JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 44 August 1954 No. 8

PALEONTOLOGY.—*Some primitive fossil pelecypods and their possible significance.* H. E. VOKES, Johns Hopkins University.

In a recent stimualting paper on "Primitive Fossil Gastropods and Their Bearing on Gastropod Classification" Dr. J. Brookes Knight (1952) presents convincing evidence to support his thesis that the Cambrian gastropods *Scenella* Billings and *Helcionella* Grabau and Shimer and their apparent immediate descendants in the Ordovician, with representatives into the Devonian, are very close to the ancestral gastropod type. All have simple cap- or spoon-shaped shells with the apex subcentral to anterior in position. Muscle scars have been observed in 6[1] of the 12 genera that he has grouped under the family Triblidiidae Pilsbry; these scars are discreet and arranged in bilaterally symmetrical pairs within the margins of the shell. Knight includes the Triblidiidae plus certain related but somewhat more advanced families and the Polyplacophora in a separate subclass of the Gastropoda for which he reintroduces Lankester's term *Isopleura*, defining it as follows (p. 45): "Gastropods that retain throughout life both in the shell and in the soft anatomy the primitive bilateral symmetry of the class. They are entirely marine and always rare. They first appear in the fossil record in Lower Cambrian rocks and carry through to the present. They probably originated in pre-Cambrian time."

The paired muscle scars are exceptionally well preserved in the genera *Archaeophiala* Koken in Perner 1903, from the Upper Ordovician of Sweden, and *Triblidium* Lindström 1880, from the Silurian of Gotland, Sweden. Both were earlier well-figured by Knight (1941, pl. 3, fig. 3a, b; and pl. 3, figs. 6a, d, respectively), and an accurate drawing of *Archaeophiala* is included in the recent paper (1952, pl. 1, figs. 3a, b) [see Fig. 1]. Concerning *Archaeophiala*, Knight (1952, p. 27) says:

> The scars are strongly pigmented and for that reason are unusually sharp and clear. These scars are 12 in number and are arranged in a ring deep within the margin of the shell. Two of the scars are larger than the others and are made up of three parts. These tripartite scars, which occur at one end, may be regarded as compound and perhaps as representing the scars of three muscles each. The other 10 scars are simple and probably are the scars of single muscles. These 12 (or 16) scars are in bilaterally symmetrical pairs. The pair of large compound scars lies at the end toward which the apex lies and very nearly closes the circle at that end. The scars of the other five pairs follow symmetrically on either side until the circle is nearly closed at the other end. There is a line of much fainter, unpigmented scars outside of the principal ring. The six (or eight) pairs of pigmented scars were probably points of attachment for symmetrically paired muscles connecting the shell to the foot. One can hardly guess what function was served by the muscles that made the more obscure scars outside those of the main circle but these shadow scars appear to be characteristic of the group.
>
> Two exceedingly important inferences are suggested by the scars of *Archaeophiala*. The first inference is that the soft anatomy was bilaterally symmetrical throughout, that is to say the animal had not undergone torsion. This is an inference primarily from the complete bilateral symmetry of the paired muscle scars, supported by the lack of an area between the scars at either end for a pallial cavity. The second inference is that the end that has the large compound muscle scars and toward which the apex lies is anterior. This follows as probable from a corollary to the principle of cephalization to the effect that

[1] Subsequent to the completion of this manuscript, Rasetti (Journ. Pal. **28** (1): 59, pl. 12, figs. 5-8. 1954) has described similarly paired scars in a Middle Cambrian species of *Scenella*, thus confirming Knight's deductions as to the position of this genus. This brings to seven the number of triblidiid genera in which such scars have been observed.

'heteronomous segmentation is an expression of cephalization.'

The muscle scars of *Triblidium* are "virtually identical" with those of *Archaeophiala* (Knight, 1952, p. 27, ftn. 10).

Recently the writer came across some notes prepared while reading Neumayr's classic "Beitrage zu einer morphologischen Eintheilung der Bivalven" (1891). In this work the author discusses certain unusual types of musculature to be observed on early Paleozoic pelecypods, stating in part (p. 754–755, freely translated):

> Further peculiarities must be observed in the muscle structure. In many geologically young forms there are three small accessory muscle impressions, in the interior of the valve close to the beak, which serve the foot muscle. This characteristic becomes more and more emphasized in the Paleozoic forms: as a representative for this I have proposed the genus, or rather, subgenus *Myoplusia*. In *Leda bilunata* these accessory muscle impressions are very highly developed (Barr. Tab. 270, f. 1, 6, 10); in one of them [tab. 270, fig. 6—see fig. 2, this paper], between the posterior adductor and the beak, there are two additional muscle impressions which equal the first in size and strength; two more-elongated impressions that extend from the beak downwards. It is, of course, a question if the very highly developed muscle structure that corresponds to such scars was only intended for the foot, but there is no evidence as to the function of this muscular structure concentrated around the beak. It becomes still more confusing in the very peculiar genus *Anuscula* from the lower Silurian [Ordovician] of Bohemia.[2]
>
> This is an oval form with a small number of teeth under a slightly protruding beak. The pear-shaped adductor muscles begin as very narrow, close to the beak and extend along the margin to almost the center of the height of the shell. The space between both adductors is filled with 4 or 5 elongated smaller muscle impressions in the region around the beak. It is not yet possible to explain these arrangements or those of *Myoplusia*. As *Anuscula* includes the geologically oldest forms that we know, we must give special attention to its peculiar characteristics and keep the possibility in mind that this muscle arrangement may have been widely developed in the still older Cambrian bivalves.

[2] BARRANDE, J.: *Syst. Silurien de Boheme* **6**: 31. Barrande used a number of Bohemian words as generic names and, apparently uncertain as to their validity, also gave latin "translations." The species referred to *Anuscula* by Neumayr were actually described under the name *Babinka*, a term that Neumayr erroneously indicates as equivalent to *Matercula* Barrande, which term Barrande uses as an alternative for his *Maminka*.

An examination of the figures of Barrande (1881, pls. 266, 269–272) reveals that there are a number of species referred by Barrande to *Babinka*, *Nucula*, and *Leda* that show multiple paired muscle scars under the beaks between the adductors. At least three different types of muscle modification may be observed in the species figured on these plates. In *Babinka* [*Anuscula*] (Figs. 6, 7) there are elongate, superficially pear-shaped anterior and posterior adductors that are prolonged dorsally toward the umbo. Between them, under the umbo, are 4 or 5 smaller elongate scars. According to Barrande the number of these supplementary scars varies within the species (see Barrande, pl. 266, figs. 6 and 15; also Figs. 6, 7, this paper). The adductor scars are 10 to 12 mm in length and approximately 2 mm wide, the supplementary scars are 5 to 6 mm long in *Babinka prima* Barrande, a species which averages 24 mm in length.

The scars of *Myoplusia* (Fig. 2)[3] have been well described by Neumayr. Those of the third group (Figs. 3, 4, 5) are well shown in "*Nucula*" *amica* Barrande, a species referred by Pfab (1934, p. 232) to his genus *Praeleda*. Here, as shown in Barrande (pl. 271, figs. 6, 8), there are three smaller elongate scars between the adductors, and a fourth dorsal to, and parallel with, the posterior adductor. In addition to these there are what appear to be smaller scars ventral to the three scars between the adductors, one below each of them, which are curiously reminiscent of the "fainter, unpigmented scars" described by Knight. The specimen figured by Pfab (1934, pl. 3, fig. 5) seems to retain part of the shell and the scars are not well shown. In sketches (pl. 1, figs. 16a, 16b) Pfab indicates, however, that the essentially pear-shaped anterior adductor of Barrande's

[3] Pfab (1934, pl. 2, fig. 11) gives a photographic figure of the original specimen of this illustration. He refers to it as *Ctenodonta* (*Ctenodonta*) *bilunata bilunata*, describing a new variety as *Ct.* (*Ct.*) *bilunata perdentata* Pfab. He makes the latter the "type" of his "Gruppe des Schlosstypus V" which includes only these two forms. He does not mention *Myoplusia* Neumayr except in the synonymy of *bilunata bilunata*.

The muscle scars, which show well in his figure, are not discussed beyond the statement that they are prominent.

figure is bi-partite, the larger portion being considered as the adductor, a smaller adumbonal portion being indicated as a pedal muscle scar; it may well have functioned as a diductor. In addition Pfab gives illustrations of *Praeleda compar* (Barrande) (1934, p. 232, pl. 1, fig. 22, pl. 3, figs. 1–3) and of *P. contrastans* (Barrande) (1934, p. 233, pl. 1, fig. 23, pl. 3, figs. 4, 7–9) of which pl. 3, figs. 2 (*compar*) and 4 (*contrastans*) show traces of musculature on the umbo similar to that shown in Barrande's figures of his "*Nucula*" *amica*. There are, thus, a number of species in the group three type that show multiple muscle scars.

The striking similarity between the general pattern of the muscle scars exhibited by these early pelecypods and those known in the triblidiid gastropods is such that, considering their approximate contemporaneity and low stratigraphic position, the writer is led to feel that conclusions of biologic significance may be drawn from it. Knight was of the opinion that the triblidiid gastropods were close to the ancestral stock from which the class was derived, and his restoration of a generalized sceneliid with the muscle scars of *Archaeophiala* (Knight, 1952, figs. 5a, b) is but little modified from that of the hypothetical primitive mollusk radical as restored by Pelseneer (1906) and others. If such was the case then it might be safe to assume that the type of musculature observed in the triblidiids was essentially similar to that to be found in the ancestral form. If this assumption be allowed, then the types of muscle scars to be observed in the early pelecypods mentioned above may be interpreted as primitive modifications from the same ancestral condition, and therefore, these pelecypods are close to the ancestral type and occupy an ancestral position in the phylogeny of the *Pelecypoda* as a whole.

If this be correct it may be concluded that the adductor muscles of the pelecypods are derived from discreet pairs of the ancestral musculature, the anterior adductor being an enlargement of the anterior pair, and the posterior adductors representing an enlargement of one of the more posterior pairs. In most of the forms it would seem that the posterior pair of muscles was enlarged to form the adductor, but if the figures of "*Nucula*" *amica* Barrande are correctly interpreted, it is evident that, in this form at least, it was the penultimate pair that was so modified.

In some respects, at least, it is tempting to consider that the type of musculature found in "*Leda*" *bilunata* reflects its closeness to the ancestral type, rather than the posterior elongation of the shell. That species, however, was said by Barrande to have come from "Sterbohol-d4." The strata at this locality are correlated by later authors with the upper Caradoc of the standard Ordovician section, approximately late Utica in terms of the North American classification. "*Nucula*" *amica* was described from the same horizon at "Butowitz," while *Babinka prima* was described from

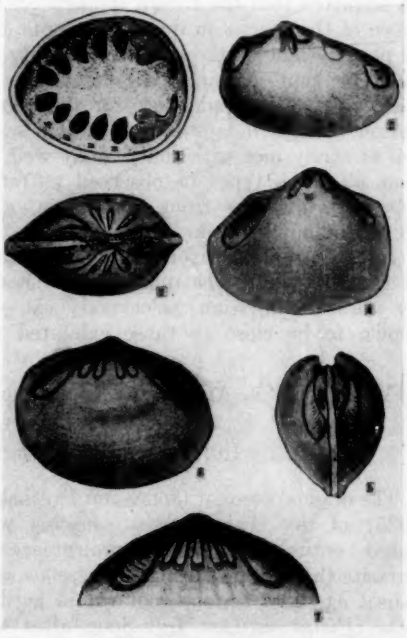

FIG. 1.—*Archiophiala antiquissima* (Hisinger), after Knight, 1952, pl. 1, fig. 3b. FIG. 2.—"*Leda*" *bilunata* Barrande; after Barrande, 1881, pl. 270, fig. 6. FIGS. 3–5.—"*Nucula*" *amica* Barrande, three views of the same specimen, after Barrande, 1881, pl. 271, figs. 6–8. FIGS. 6–7.—*Babinka* [*Anuscula*] *prima* Barrande, after Barrande, 1881, pl. 266, figs. 11 and 15, respectively. (All except figure 7 approximately natural size.)

"Wosek-d1," strata that are now considered as U. Arenig or L. Llandeilo (Chazyan) in age. It has also been reported as occurring in strata of Upper Tremadoc and L. Arenig age in the Herault area of southern France. (Thoral, 1935, p. 162, pl. 13, figs. 4a, b, 5a, b).

It is clear, therefore, that the symmetrical *Babinka prima* type is the older. However, it seems quite unlikely that either the hinge types, nor the peculiar muscle patterns that mark *"Leda" bilunata* and *"Nucula" amica* could have been derived from those to be observed in *Babinka prima*. Two alternatives may be suggested: (1) that all three were derived from presently unknown pelecypod ancestors, or (2) that these early pelecypod types were polyphyletic in origin, and were separately derived from the prepelecypod ancestral stock. While it must be admitted that the known geologic occurrence of the species in question tempts one to place weight on the second possibility, it must be kept in mind that conditions of fossil preservation adequate for the observation of such details as the muscle scars are so rarely met with that it may well be that all three types of observed patterns represent offshoots from a common, and as yet unknown, stock.

In conclusion, therefore, it is the opinion of the writer that the muscle scars shown by these Ordovician pelecypods can be shown to be close to those exhibited by primitive gastropods, as figured by Knight; that they therefore may be interpreted as reflecting the musculature present in the ancestral stock from which the Pelecypoda were derived; and, in view of their similarity to the gastropod condition, that they afford evidence confirmatory to the arguments of Knight that the gastropods of the family Triblidiidae are close to the ancestral stock in the gastropod line. Further, they suggest that the adductor muscles of the Pelecypoda are derived from discreet pairs of the ancestral musculature, rather than from the union of multiple pairs.

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MYCOLOGY.—Aphanomyces euteiches *from pea roots and* "Aphanomyces euteiches *P. F. 2.*" CHARLES DRECHSLER, United States Department of Agriculture, Plant Industry Station, Beltsville, Md.

The original account (Jones and Drechsler, 1925) of my *Aphanomyces euteiches* was based entirely on the saprolegniaceous parasite that occurs during wet seasons as a causal agent of serious root rot in garden peas (*Pisum sativum* L.). Soon after the account was published Linford (1927) reported having found oospores typical of the fungus also in diseased roots of narrow-leaved vetch (*Vicia angustifolia* L.) seedlings as well as in diseased seedlings of alfalfa (*Medicago sativa* L.) and sweet clover (*Melilotus alba* Desr.). He further observed several varieties of sweet peas (*Lathyrus odoratus* L.) greatly weakened from spontaneous attack by the parasite, and in inoculation trials successfully infected nine additional leguminous species. Mainly because of similarities shown by oospores found in their decaying roots he considered four nonleguminous plants including barley (*Hordeum vulgare* L.) and oats (*Avena sativa* L.) subject to invasion by *A. euteiches*. Subsequent study of a culture isolated by Linford from an oat root, however, revealed distinctive morphological and developmental features; wherefore it was used as type material of a separate species, *A.*

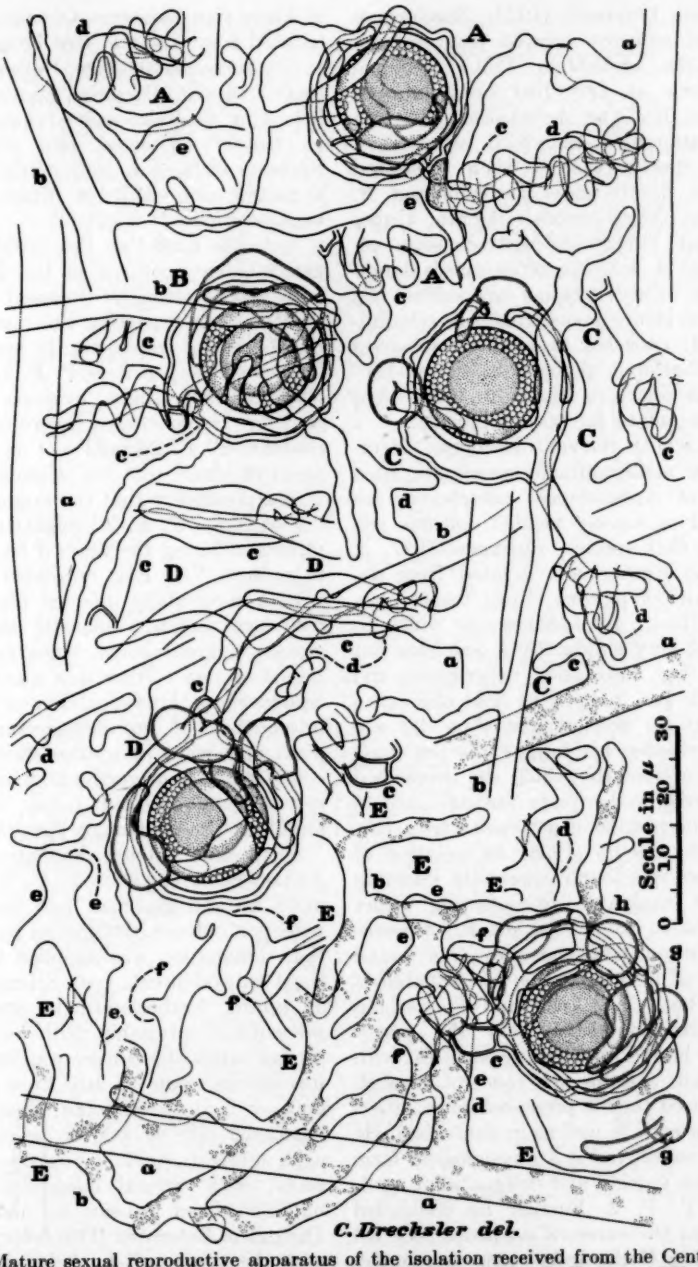

FIG. 1.—Mature sexual reproductive apparatus of the isolation received from the Centraalbureau voor Schimmelcultures at Baarn, Netherlands, as *Aphanomyces euteiches* P. F. 2; × 1,000 throughout. A–D, Diclinous reproductive units, with one mycelial hypha, a, supplying the oogonium, and another hypha, b, supplying the attendant antheridia. E, Reproductive unit with traceable mycelial connection between the stout mycelial filament, a, that supplies the oogonium and the hypha, b, that supplies the 5 attendant antheridia. For greater clearness some of the more complicated portions of the several units (A, c–e; B, c; C, c, d; D, c, d; E, c–h) are shown separately as well as in proper position.

camptostylus Drechsler (1929). Similarly a number of cultures isolated from tomato (*Lycopersicon esculentum* Mill.) roots in 1926, which at first had been referred (Drechsler, 1927) to *A. euteiches*, were on closer examination found to represent a different species that I then presented (Drechsler, 1929) under the binomial *A. cladogamus*. More recently Doran, Guba, and Gilgut (1942) in Massachusetts reported that *A. euteiches* often causes damping-off of celery (*Apium graveolens* L.). Detailed evidence concerning the relationship of *A. euteiches* to any *Aphanomyces* cultures that may perhaps have been isolated from celery or barley in the United States has not so far been supplied.

In the scanty relevant European literature a few nonleguminous plants are cited as hosts of *Aphanomyces euteiches* or are mentioned as having yielded cultures referable to that species. Buisman (1927, p. 45) in the Netherlands isolated from decaying roots of pansies (*Viola tricolor* var. *hortensis* Hort.) an *Aphanomyces* which to her looked very similar to *A. euteiches* but which in her inoculation experiments did not attack pea roots. She was unable to try it out on pansies and thus did not establish whether her fungus was the cause of an acute root rot which she mentioned as appearing in her experimental garden. In cross-inoculation experiments later carried out by Meurs (1928) an isolation of *A. euteiches* was found capable of infecting peas, but incapable of infecting either *Viola tricolor* or *V. cornuta* L.; whereas the pansy-root *Aphanomyces* was found incapable of infecting peas, but capable of infecting both *V. tricolor* and *V. cornuta*. Meurs, like Buisman, held the pansy fungus to be morphologically identical with the parasite causing pea root rot, though he recognized that it presented some differences in growth as well as in parasitism. He therefore considered it a physiological form of the same species, and designated it as *A. euteiches* P. F. 2. Further he concluded that it was the cause of an acute root rot of pansies in Holland. It seems noteworthy that Meurs came to this conclusion even though he had obtained from the pansy other fungi that might have been regarded as likely root parasites. Of nine cultures he isolated from *Viola tricolor* he assigned two to *Pythium intermedium* DeBary and four to *P. irregulare* Buisman, and listed two as belonging to undetermined species. Besides *V. tricolor* he listed two other plants, *Spinacia oleracea* L. and *Arabis alpina* L., as having each yielded a culture of *Aphanomyces euteiches* P. F. 2.

A decade later Van Eek (1938) reinvestigated pansy root rot in the Netherlands with results strongly divergent from those of Meurs. In repeating the tests described by Meurs and employing the same strain of "*Aphanomyces euteiches* P. F. 2," Van Eek obtained only slight evidence of pathogenicity. He concluded accordingly that *A. euteiches* P. F. 2 could not be the causal agent of severe root rot of pansies. In view of the possibility that the original strain of "*A. euteiches* P. F. 2" might have lost its virulence during the years it had been kept in culture Van Eek reisolated the strain from a successfully infected plant, but the recovered isolation likewise showed only meager aggressiveness. Apparently he obtained no new culture that was referable to *Aphanomyces*. However, despite the general infrequence of saprolegniaceous fungi as plant pathogens he isolated two such fungi —his *Brevilegnia gracilis* and his *B. macrospora*—from diseased pansy plants and found both to be strongly parasitic.

Soon after Meurs had designated as *Aphanomyces euteiches* P. F. 2 the water mold he and Buisman had isolated from pansies a culture contributed by him under that designation was supplied to me from the Centraalbureau voor Schimmelcultures at Baarn, Netherlands. In observance of precautions advisable with organisms of foreign origin the culture was never used in inoculation trials of any kind either outdoors or in the greenhouse. However, it was compared side by side on several different agar substrata with *A. euteiches* from pea roots, with several congeneric isolations obtained from pansies in and near the District of Columbia (Drechsler, 1934), and with the strains of *A. cladogamus* obtained from roots of flax (*Linum usitatissimmum* L.) and spinach (*Spinacia oleracea* L.) in the United States (Drechsler, 1935). The

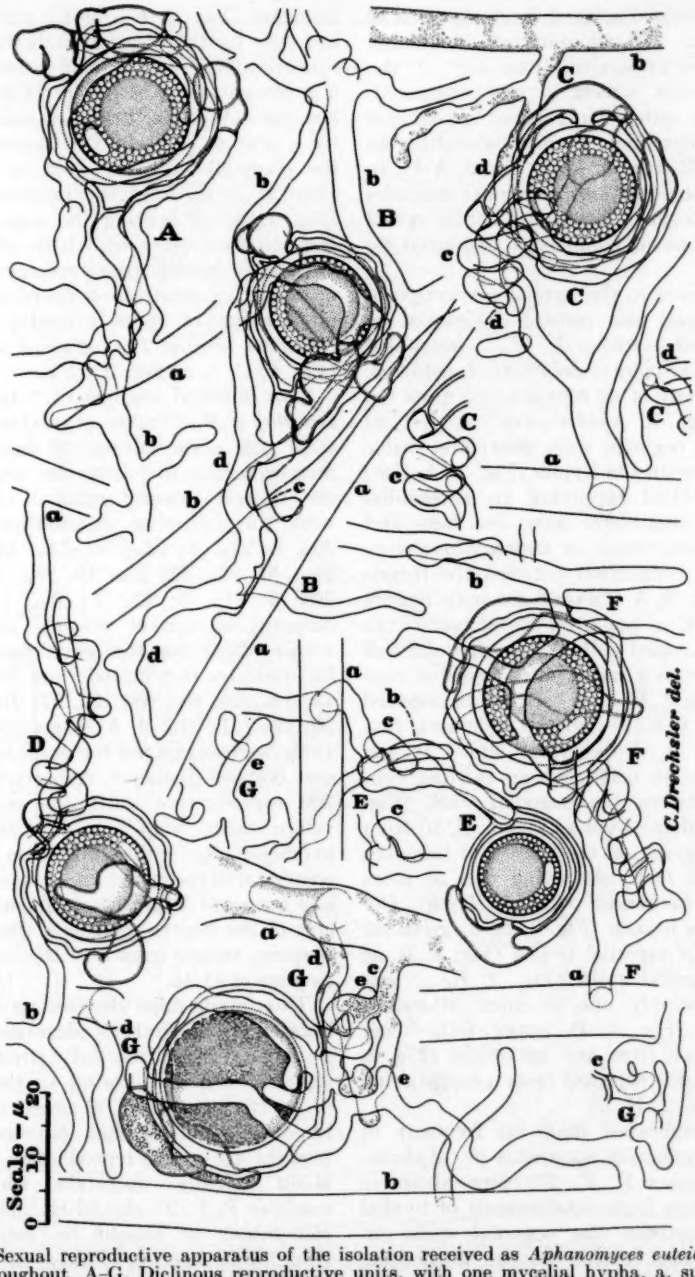

FIG. 2.—Sexual reproductive apparatus of the isolation received as *Aphanomyces euteiches* P. F. 2; × 1,000 throughout. A–G, Diclinous reproductive units, with one mycelial hypha, a, supplying the oogonium, and another hypha, b, supplying one (B, E) or more (A, C, D, F, G) attendant antheridia; in B two antheridia of monoclinous origin (upper left, lower middle) are present besides, these being supplied from a branch, d, that is given off by the same hypha as the oogonial stalk, c. Oospore in early stage of development in G, but fully mature in A–F. For greater clearness some of the more complicated parts in three of the units (C, c, d; E, c; G, c–e) are shown separately as well as in proper position.

Dutch isolation displayed generally greater intricacy in the make-up of its sexual reproductive apparatus than any of the isolations with which it was compared. Despite the rather complicated appearance of the 15 reproductive units figured herein (Fig. 1, A–E; Fig. 2, A–G; Fig. 3, A–C) to show the postural and positional relations of the sex organs, these units hardly reveal the full scope of complexity displayed by the fungus.

With respect to the hyphal connection of its sex organs the culture designated as *Aphanomyces euteiches* P. F. 2 resembled *A. cladogamus* more closely than *A. euteiches*. While in many of its reproductive units the hypha (Fig. 1, A–D:a; Fig. 2, A–G:a) bearing the oogonial stalk showed no visible connection with the hypha (Fig. 1, A–D:b; Fig. 2, A–G:b) supplying an antheridial branch, it commonly gave rise here and there to monoclinous or androgynous units in which a connection between the female branch (Fig. 3, A–C:a) and the male branch (Fig. 3, A–C:b) could be traced readily. In more complicated units it was often difficult to follow even a fairly short mycelial connection (Fig. 1, E, d, e) between an oogonial stalk (Fig. 1, E, c) and the wide axial filament (Fig. 1, E, a) from which it was supplied, or to make out an existing connection between the oogonial stalk (Fig. 1, E, c) and the hypha (Fig. 1, E, b) from which was given off the branch or branches (Fig. 1, E, f, h) supplying one or more attendant antheridia (Fig. 1, E, g). Occasionally a branch (Fig. 2, B, d) given off by the same mycelial hypha (Fig. 2, B, a) as the oogonial stalk (Fig. 2, B, c) was found to supply one or more attendant antheridia (Fig. 2, B, upper left, lower middle) apart from any antheridia (Fig. 2, B, lower right) supplied from a neighboring hypha (Fig. 2, B, b).

The complicated make-up frequent in sexual reproductive apparatus of "*Aphanomyces euteiches* P. F. 2" came about in large measure from entwinement of hyphal parts. Sometimes the oogonial stalk entwined a ramification of the antheridial branch (Fig. 1, B). Sometimes an antheridial branch (Fig. 1, E, f) or the terminal portion of a hypha bearing one or more antheridial branches (Fig. 2, C, D, F) was entwined not only by the oogonial stalk but also by short ramifications borne on it. Often, again, a prolongation of a hypha (Fig. 1, A, c) bearing antheridial branches was entwined by a branch (Fig. 1, A, c) given off from the oogonial stalk, or even by a branch (Fig. 1, A, d) from the mycelial filament (Fig. 1, A, a) bearing the oogonial stalk. Reproductive units with little of no intertwining of hyphal parts acquired in many instances an intricate appearance through interlocking of spurs extended from the branches bearing the apposed sex organs (Fig. 1, C, c, d: Fig. 2, E, c).

Two hundred oogonia of "*Aphanomyces euteiches* P. F. 2" taken at random in maize-meal agar plate cultures 30 days old gave measurements for diameter, expressed in the nearest integral number of microns, with the following distribution: 18μ, 1; 20μ, 5; 21μ, 6; 22μ, 16; 23μ, 18; 24μ, 33; 25μ, 40; 26μ, 35; 27μ, 19; 28μ, 13; 29μ, 6; 30μ, 3; 31μ, 3; 32μ, 1; 33μ, 1. The 200 oospores of correct internal organization within these oogonia gave measurements for diameter distributed thus: 16μ, 4; 17μ, 13; 18μ, 26; 19μ, 38; 20μ, 47; 21μ, 38; 22μ, 20; 23μ, 11; 24μ, 3. Averages of 25.0μ and 19.8μ were computed for oogonial diameter and oospore diameter, respectively. In the 200 reproductive units the oogonial envelope varied from .5 to 1.3μ in thickness, averaging .8μ in this dimension; while the oospore wall measured 1 to 1.9μ in thickness and averaged 1.5μ. Measurements for diameter of the reserve globule in the individual oospores ranged from 9 to 16μ, and gave an average of 11.4μ.

Thus in its main dimensions the culture isolated in the Netherlands would not seem to have differed markedly from *Aphanomyces cladogamus*. Owing to the difficulty of ascertaining from a single culture the importance of hyphal entwinement attendant to sexual reproduction it appears about equally uncertain whether "*A. euteiches* P. F. 2" should be included in *A. cladogamus* or should be kept separate from that species. Study of additional cultures from pansies in the Netherlands may be necessary before a sound decision can be reached as to the proper disposition

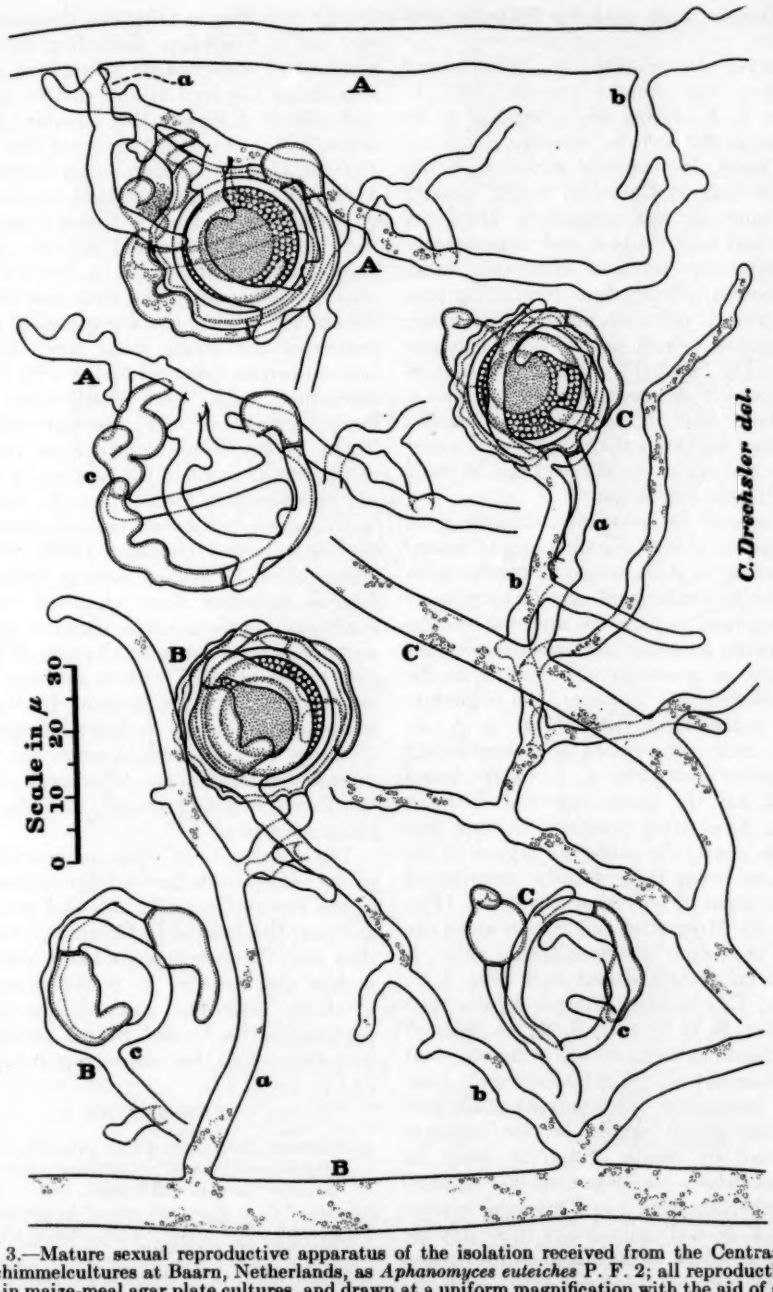

FIG. 3.—Mature sexual reproductive apparatus of the isolation received from the Centraalbureau voor Schimmelcultures at Baarn, Netherlands, as *Aphanomyces euteiches* P. F. 2; all reproductive units formed in maize-meal agar plate cultures, and drawn at a uniform magnification with the aid of a camera lucida; × 1,000 throughout. A–C, Monoclinous reproductive units, showing mycelial connection between the hyphal branch, a, supplying the oogonium and the hyphal branch, b, supplying the attendant antheridia; for greater cleanness the entire male complement of each unit is shown besides in a separate drawing, c.

of the fungus dealt with by Buisman and by Meurs.

Whatever its relation to *Aphanomyces cladogamus* the fungus received as *A. euteiches* P. F. 2 was assuredly not to be held conspecific with *A. euteiches* occurring in pea roots. Its oogonial envelope, being relatively thin and pliable, would usually shrink more or less irregularly after the oospore had been formed, and consequently in mature reproductive apparatus most often showed a somewhat undulating profile. In true *A. euteiches*, on the other hand, the oogonial envelope is conspicuously thicker (Fig. 4, A–F). After formation of the oospore it behaves more nearly like a rigid shell, and in agar culture usually maintains its smoothly spherical outer contour for many weeks without evident change in size and shape.

Pronounced helicoid intertwinement of hyphal parts is not characteristic of sexual reproduction in *Aphanomyces euteiches* from pea roots. In maize-meal agar plate cultures of the pea-root parasite the mycelial connection between an oogonium and its attendant antheridia is generally too remote to be traced. Sometimes, however, the oogonium of one reproductive unit (Fig. 4, A, a) and the male complement of a neighboring reproductive unit (Fig. 4, A, b) are found supplied by the same mycelial filament (Fig. 4, A, c) from positions perhaps less than 50μ apart; the other sex organs of the two units being then usually contributed by two separate mycelial filaments (Fig. 4, A, d, e). Most often one hypha gives rise to the oogonium either distally (Fig. 4, B, a) or on a short lateral stalk (Fig. 4, C, a; D, a; E, a), while another hypha near by (Fig. 4, B, b; C, b; D, b; E, b) gives off the antheridial branch or branches that bear terminally all the attendant male cells. Rather commonly the oogonial stalk and antheridial branch appear in some measure interlocked by means of lateral spurs. In instances where an oogonium is supplied with antheridia from 2 or 3 mycelial hyphae (Fig. 4, F, b, c, d) only one of these hyphae (Fig. 4, F, b) is usually found interlocked with the mycelial filament (Fig. 4, F, a) giving off the oogonial stalk.

Aphanomyces euteiches was listed by Dennis and Foister (1942) as the cause of a root rot of *Viola* spp. (including the pansy and violet) observed by them in 5 regions comprising the central and eastern sections of Scotland. A typewritten circular (Anonymous, 1931) issued earlier from the Royal Botanic Garden in Edinburgh stated that Violas grown on the same land for a number of years often contract a disease from which the stem turns brown and shrivels, and the leaves turn yellow; death of the individual plants ensuing after the stem has decayed for an inch or two. On microscopical examination of the stem, collar, and decaying root numerous spherical bodies with slightly thickened walls were observable, being found mainly in the vascular elements. These bodies were identified as oospores of the causal agent of the root rot, a species of *Aphanomyces* similar to *A. euteiches*. Yet no species of *Aphanomyces* is mentioned by Chesters and Hickman (1939, 1944) in either of the 2 papers setting forth some fungus parasites they observed through examination of numerous varieties of *Viola* and pansy received from all parts of Britain and found affected with a soft rot of the stem or of the root system. In the final stages of the disease complex discussed by Chesters and Hickman, much as in the disease described in the Edinburgh circular, the leaves wilt and shrivel, and the whole plant collapses.

The occurrence of *Aphanomyces* oospores in the woody cylinder—a feature noted also in the roots of severely diseased pansies in and near the District of Columbia—suggests that the *Aphanomyces* attacking cultivated violets and pansies in Scotland may be identical with the species that attacks pansies in the United States rather than with the species that causes root rot in peas.

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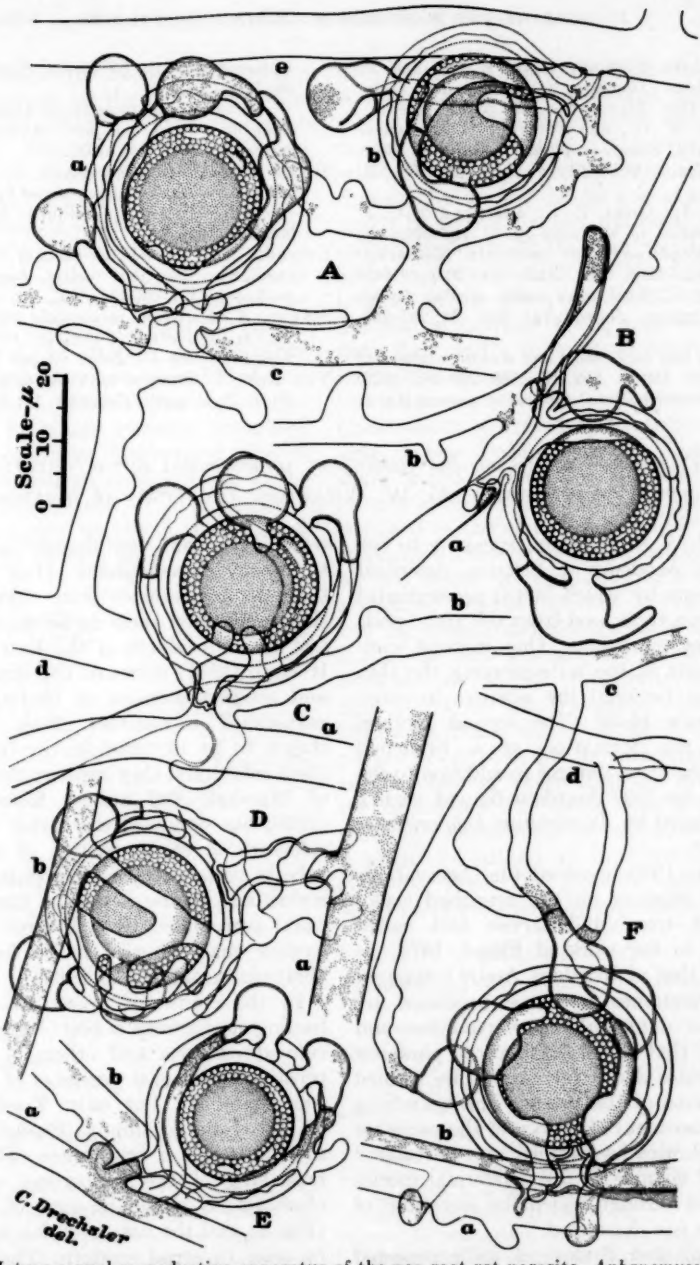

FIG. 4.—Mature sexual reproductive apparatus of the pea root-rot parasite, *Aphanomyces euteiches*; all reproductive units formed on the under side of maize-meal agar plate cultures; × 1,000 throughout. A, Two connected reproductive units, a and b; c, mycelial hypha supplying the oogonium of unit a and the antheridia of unit b; d, mycelial hypha supplying antheridia of unit a; e, mycelial hypha supplying oogonium of unit b. B–E, Diclinous reproductive units, each showing origin of oogonium from one mycelial hypha, a, and origin of attendant antheridia from a neighboring hypha, b. F, Diclinous reproductive unit showing oogonium supplied by one mycelial hypha, a, and its male complement of 5 antheridia supplied conjointly by 3 neighboring hyphae, b–d.

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ZOOLOGY.—*Observations on the feeding of prostigmatid larvae (Acarina: Trombidiformes) on arthropods.*[1] G. W. WHARTON, University of Maryland.

In 1892 M. S. Jourdain, speaking to the Parisienne Academy of Science, described two methods by which larval prostigmatid mites obtain their food from the arthropods which they parasitize. One method consisted simply of the mite piercing the thin integument between the sclerites in order to withdraw blood. The second method involved the formation of a branched feeding tube or stylostome in addition to the puncture. In 1899 Jourdain figured such a tube produced by *Trombidium holosericieum* in its host.

André in 1930 reviewed the observations of earlier workers on the branched stylostomes of trombidiid larvae and called attention to the work of Flögel, 1876, as well as to that of Jourdain. André compared these stylostomes to those produced by *Trombicula autumnalis* in vertebrates and concluded that the stylostomes of parasites of vertebrates and invertebrates are formed by secretions of the larvae. The branching of the stylostomes of certain of the parasites of invertebrates he ascribed to a postulated system of lacunae in the subdermal tissues of the host through which the secretions of the larvae are channeled.

Marshall and Staley in 1929 reported and figured unbranched stylostomes in mosquitoe larvae produced by larvae of water mites that were thought to be similar to *Lebertia tauinsignata.* They recognized that the stylostomes were subdermal but they considered them to be made of chitin and to be products of the host. Feng and Hoeppli (1933) reviewed the entire problem and studied sections of feeding tubes in parasitized mosquitoes. Host cells were shown to be involved in the formation of these tubes, and they support the conclusion of Marshall and Staley. Recently Jones (1950) has discussed the earlier works with reference to the formation of the feeding tube in vertebrates. He recognized that the stylostome was made up of a narrow central canal surrounded by a hyaline mass. The hyaline mass is said to be formed from keratinized malpighian cells.

In the course of investigations on the feeding mechanisms of pest chiggers, *Trombicula alfreddugèsi* and others, a number of prostigmatid larval parasites of arthropods was examined, but only *Trombidium* sp. on the common firefly *Photuris pennsylvanica* formed a stylostome. The multiple branching of the stylostome was readily observed in whole mounts of dissections (Fig. 1), and the nature of the wound could be seen in serial sections. The larvae attached themselves to the synarthrodial membranes between the anterior abdominal sclerites beneath the elytra. The larvae were invariably aligned with the long axis of the host with their anterior ends directed

[1] This work was supported by a grant from the National Institutes of Health, U. S. Public Health Service, to Duke University.

toward the head of the beetle. The primary mechanical rupture of the thin host membrane was made solely by the chelicerae of the larva. The tips of the chelicerae penetrated the haemocoel. Within the haemocoel the branched stylostome was formed. It consisted of a heavy basal portion that gave off two main branches each of which branched again. A branched tube in the center of the stylostome connected the preoral cavity of the larva with the tips of the branches of the stylostome. The distal ends of the stylostome were expanded into a terminal knob. These knobs occurred in clumps and in whole mounts resembled tiny bunches of grapes. The central canal of the stylostome did not open directly at the tip of the knob; instead, it gave rise to a group of secondary canaliculi that opened over the surface of each knob.

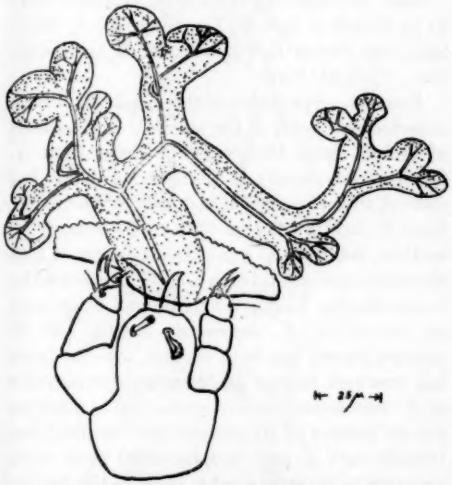

FIG. 1.—Feeding tube of *Trombidium* sp.

Since the stylostome in question is formed in the haemocoel, André's explanation of its branching cannot apply. It is also probable that the stylostome is not made of chitin produced by the host as suggested by Marshall and Staley since in sections treated with a polychrome stain the stylostome is stained deep red and the cuticle of the mite and beetle do not take the stain. No cells of any kind are associated with the tube. Unfortunately the mechanics of formation of the stylostome as well as the nature of the material of which it is formed remain in doubt. However, if the salivary secretions of the mite were precipitated by the host tissues a solid structure would be formed within the host. Solidification would occur first at the interface between the saliva and the blood. Thus as long as saliva was poured into the host, the central portion of the mass would remain fluid and a tube would result. When the mite began removing blood from the host, salivary secretion would stop and blood would be sucked up the tube into the mite. When feeding ceased, saliva would again be free to flow down the tube and the structures would grow as more saliva precipitated at the end of the tube. The characteristic branching of the stylostome might be the result of localized differences in interfacial tension between saliva, blood, and the coagulum produced by a combination of the two. The salivary glands do not open into the mouth or pharynx, but pour their secretions into the space between the chelicerae. Since this is in effect an open groove it is difficult to understand how saliva could be forced into the wound by the chelicerae. The saliva would however normally pass into the preoral cavity where it might be sucked up into the muscular pharynx. From the muscular pharynx it could be ejected forcibly into the host.

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ENTOMOLOGY.—*Five new species of chrysomelid beetles.* DORIS H. BLAKE, Arlington, Va.

The following new species of chrysomelid beetles, including a new genus of flea beetles from the West Indies, have come to the writer's attention.

Xanthonia flavoannulata, n. sp.
Fig. 1

Between 5 and 6.5 mm in length, oblong oval, faintly shining beneath the closely appressed pubescence; head and pronotum densely punctate, the elytra with coarser striate punctures; prothorax with two humps, elytra with a slight depression below basal callosities, all femora toothed; head mostly dark piceous, the lower front deep reddish, antennae reddish brown with apex of each joint often paler; prothorax varying from deep reddish brown with irregular dark areas to piceous; elytra variable in markings from yellowish or reddish brown with irregular piceous mottling to almost entirely piceous; legs and body beneath dark, the legs with pale rings.

Head densely and coarsely punctate throughout and with short closely appressed pubescence, sometimes the pubescence forming pale spots on vertex, front flat and broad with only a faint median line and no trace of frontal tubercles and a wide flat interantennal area having on each side a wide and moderately deeply excavated antennal socket. Head deep piceous above, paler reddish in lower front, the mouthparts yellowish with large shiny piceous jaws. Antennae not reaching the middle of the elytra, slender becoming a little wider in distal joints, reddish or yellowish brown with the apex of each joint a little paler, fourth and seventh joints longer than the rest. Prothorax not twice as broad as long, coarsely punctate throughout, the punctures extending around to coxal cavities, covered with short, closely appressed pale pubescence; disc with depression anteriorly, behind this a knobby callosity on each side of middle, these callosities and median line without pubescence and darker in some specimens, often the entire disc piceous. Scutellum covered with pale pubescence. Elytra with basal callosity and depression below this, towards apex the intervals between the striate punctures becoming costate; striate punctures moderately coarse, not very dense, partially covered by the pale closely appressed pubescence; color of pubescence as well as surface varying from yellowish or reddish brown to deep piceous, pattern extremely variable, from pale yellow brown with irregular dark mottlings to almost entirely piceous with paler humeri and a few small patches of white pubescence; the paler spots more in evidence towards apex. Body beneath shining piceous with closely appressed pale pubescence. Femora and tibiae dark with pale rings beyond middle and at apex; tarsal joints usually pale; all femora toothed, the anterior ones with larger tooth. Length 5.2 to 6.5 mm; width 2.5 to 3.2 mm.

Type male and 51 paratypes, U.S.N.M. no. 62281, 1 paratype in M.C.Z., Cambridge, Mass.

Type locality.—Taken at Laredo, Tex., in shipments of orchids from "Cd. del Malz," San Luis Potosí, Mexico, October 14, 1944, November 29, 1946, January 14, 1947, and March 1, 1947.

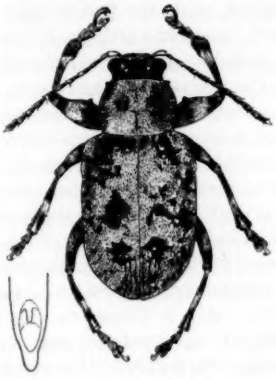
Other localities.—Chilpancingo, Guerrero (taken on orchids at Laredo, Tex., February 4, 1947); San Luis Potosí (taken on orchids at Laredo, Tex., April 20, 1947).

Remarks.—Specimens of this species have been collected repeatedly at Laredo, Tex., in shipments of orchids from Mexico. They differ from *X. guatemalensis* Jacoby in that the prothorax has distinct tubercles, one on each side of the middle; from *X. jacobyi* Clav. in that all the femora are toothed, and from *X. nigrofasciata* Jacoby in that the elytra are not tuberculate. That species also is described as having a longitudinal black band on the elytra. *X. marmorata* Jacoby and *X. tuberosa* Jacoby are both smaller, and the latter has unarmed femora. In his original description of *X. marmorata*, Jacoby wrote that it could be known because of its minute size (one line) and because each elytron had about 10 black spots arranged in transverse rows. Later in the Supplement[1] under *X. marmorata* he wrote that there were a few specimens from Chilpancingo in which the elytral spots form irregular patches, and there was a wide variation in size, sculpture and markings. It is possible that he may have had specimens of this species that he confused with *X. marmorata*.

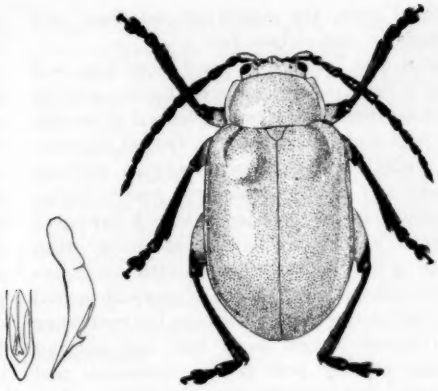
Blepharida pallida, n. sp.
Fig. 5

About 7 mm in length, oblong oval, faintly shining, pale yellow with the tip of the terminal

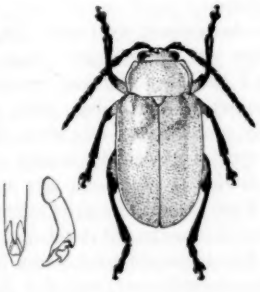
[1] Jacoby, Biol. Centr. Amer., Coleoptera, **6**, pt. 1. Suppl.: 231. 1891.



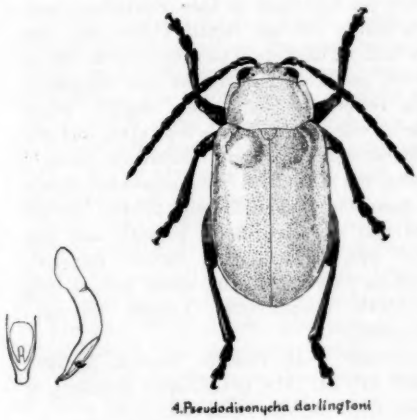
1. Xanthonia flaveannulata



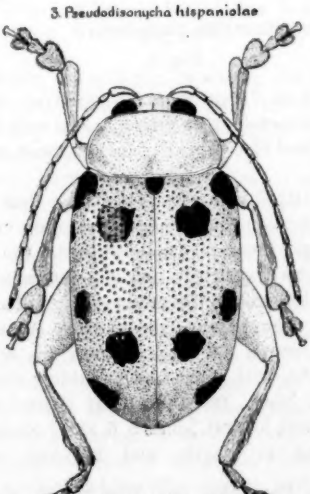
2. Pseudodisonycha portoricensis



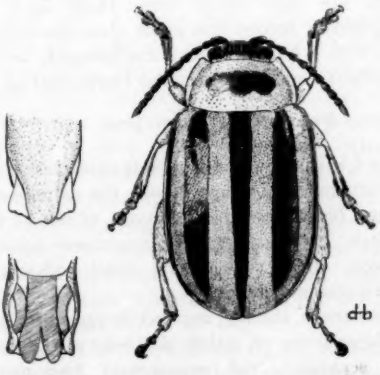
3. Pseudodisonycha hispaniolae



4. Pseudodisonycha darlingtoni



5. Blepharida pallida



6. Oedionychus rhabdotus

FIGS. 1–6.—New chrysomelid beetles.

antennal joint, the mandibles, scutellum, and six spots on each elytron dark.

Head with interocular space more than half width of head, pale yellow except tip of mandibles which are deep reddish brown, occiput alutaceous and with scattered punctures, frontal tubercles not distinct, a slight carina between antennal sockets and a deep transverse groove below. Antennae long and slender, pale with the tip of terminal joint dark, third joint shorter than fourth or fifth and subequal to sixth. Prothorax approximately twice as broad as long with curved sides and narrow margin, a sunken line continuing from lateral margin along base and anterior margin; entirely pale yellow, alutaceous and distinctly but not densely punctate, surface somewhat uneven with lateral depressions and one over the scutellum at base. Scutellum dark. Elytra faintly shining, faintly alutaceous, pale yellow with six dark spots on each elytron, one on humerus, one below humerus on side and one in middle below scutellum, one slightly below middle on side, one in middle near apex, and one on side below this near apex; densely and coarsely punctate, the punctation being somewhat striate near base but not definitely striate beyond middle and on sides. Body beneath and legs entirely pale yellow. Hind femora enlarged, hind tibiae with short spur, claws with a long basal tooth, almost bifid. Length 6.8 mm; width 4 mm.

Type male, from Venedio, Sinaloa, Mexico, collected July 31, 1918, in California Academy of Sciences, from the Van Dyke collection.

Remarks.—This is a most distinctive species of *Blepharida*. Two others from Mexico and Central America are pale yellow with black spots. *B. 14-punctata* Jacoby has seven spots on each elytron with a quite different arrangement, and *B. singularis* Jacoby has irregular black spotting.

Pseudodisonycha, n. gen.

From 4 to 7 mm in length, oblong oval, shining, nearly impunctate, yellow brown, the antennae stout and black, the tips of femora, tibiae, and tarsi dark; prothorax without transverse basal depression, elytra with strong basal callosity and a depression below.

Head smooth, shining, impunctate except for a single large fovea on either side near eye, eyes widely separated, not emarginate. Antennae extending about to the middle of the elytra, unusually robust, with the fourth joint longer than the third, fourth and fifth joints wider and longer than preceding or following, the sixth and following joints gradually diminishing in length and width in both sexes. Prothorax not quite twice as broad as long, with slightly curved sides, smoothly rounded and without callosities, the explanate margin not very wide; the anterior and basal angles as in *Disonycha* with a slight pinched-in depression at basal angle, no sign of transverse basal depression. Elytra with prominent humeri, a pronounced intrahumeral depression and a basal callosity, below this a transverse depression. Body beneath with open anterior coxal cavities, the hind femora enlarged, hind tibiae with short spur, first tarsal joint of hind legs as long as the next two together, the first tarsal joints of the anterior pairs of legs in the male much swollen; claws appendiculate.

Genotype: Pseudodisonycha darlingtoni (Blake).

Remarks.—This is exceedingly close to *Disonycha*, and I described the first species as *Disonycha darlingtoni*[2] (from Cuba). Since then two others have come to my attention. They form a group of species very similar to each other in shape and coloration that appears to be endemic in the West Indies. The chief difference between them and *Disonycha* lies in the antennal characters, the five basal antennal joints being thicker than the terminal ones, and the elytral callosities and accompanying transverse depression before the middle.

Pseudodisonycha portoricensis, n. sp.
Fig. 2

From 6 to 7 mm long, oblong oval, shiny, nearly impunctate, pale yellow brown with black antennae and black apices of femora, black tibiae and tarsi.

Head with interocular space more than half width of head, polished and impunctate except for a single fovea on each side near the eye, frontal tubercles faintly marked, interantennal area rounded and slightly produced and extending down short lower front, labrum small. Antennae extending nearly to the middle of the elytra, robust, the first joint deep reddish brown, remainder black, the third joint shorter than fourth, fourth longest, joints 5, 6, and 7 gradually diminishing in length, and terminal joints

[2] Blake, Proc. Ent. Soc. Washington, **40**: 50. 1938.

thinner and shorter. Prothorax not quite twice so broad as long with the sides only slightly rounded, anterior and basal angles as in *Disonycha*, little trace of transverse basal depression; disc moderately convex, smooth, almost impunctate. Elytra with deep intrahumeral sulcus and a distinct basal callosity with a depression below it; surface shiny, almost impunctate, pale yellow brown. Undersurface pale, the apex of the femora, tibiae and tarsi black; anterior coxal cavities open. Hind tibiae with a short spur, claws appendiculate. Length 6 to 7 mm; width 3.5 mm.

Type, male, M.C.Z. no. 29267, collected May 30–June 2, 1938, in Maricao Forest, 2,000–3,000 feet, Puerto Rico, by P. J. Darlington.

Other localities.—One other specimen, a male, from the Stuart Danforth collection, collected at Mayagüez, Puerto Rico, in December 1932, by J. Vick.

Remarks.—This species is larger than the Cuban one and the tip of the femora alone is dark; in the Cuban species the femora are more or less dark. One specimen, a female from Constanza, Dominican Republic, collected at 3,000–4,000 feet altitude, in August 1938 by P. J. Darlington, is very similar to this species but is probably distinct from it. The head is unlike it in having a less pronounced and smaller carina. I hesitate to describe it from only one female specimen.

Pseudodisonycha hispaniolae, n. sp.

Fig. 3

Between 4 and 5 mm in length, oblong oval, shiny, nearly impunctate, pale yellow-brown, with heavy black antennae and apices of femora and black tibiae and tarsi.

Head except for a single fovea on each side near eye impunctate, smooth and shining, frontal tubercles lightly marked, interantennal area rounded and a little produced, lower front short. Antennae extending almost to the middle of the elytra, entirely dark, robust, fourth joint longer than third and succeeding ones gradually diminishing both in length and width. Prothorax almost twice as wide as long with slightly rounded sides, anterior and basal angles as in *Disonycha*, a pinched-in sort of depression at basal angle, no trace of transverse basal depression, surface moderately convex and shiny, impunctate. Elytra with strong intrahumeral sulcus and a depression below basal callosity, shiny, impunctate. Body beneath pale with the apices of the femora and whole of tibiae and tarsi dark. Length 3.9 to 4.6 mm; width 2.2 to 2.5 mm.

Type male, M.C.Z. no. 29268, and 1 paratype (female) collected on Mount Diego de Ocampo, Dominican Republic, 3,000–4,000 feet altitude, July 1938, by P. J. Darlington. One paratype in U.S.N.M., no. 62282.

Remarks.—This is smaller than either the Cuban or Puerto Rican species but otherwise very similar except for differences in the shape of the aedeagus.

Oedionychus rhabdotus, n. sp.

Fig. 6

Between 6.5 and 8 mm in length, oblong oval, shining, strongly punctate, the head deep reddish brown on occiput, paler on lower front, body beneath and legs reddish brown; prothorax and elytra yellow with a median dark fascia on prothorax and a sutural, median and submarginal dark vitta on elytra, a groove of deep, coarse punctures in the intrabumeral sulcus.

Head deep reddish brown on occiput and coarsely and densely punctate even on tubercles, a median line running down between the tubercles, lower front paler. Antennae deep reddish brown to piceous, rather short, not coming much below humeri, the third joint almost as long as fourth. Prothorax more than twice as wide as long, smoothly convex with rounded sides and explanate margin, a small tooth at apical angle, surface alutaceous but somewhat shiny and deeply and densely punctate; pale yellow brown with a broad dark median transverse fascia of variable length and shape but not extending to the explanate margin. Scutellum dark, finely alutaceous. Elytra shining, deeply and densely and moderately coarsely punctate, a groove of deep coarse punctures extending down the intrahumeral sulcus; yellow brown with a moderately wide sutural, median and narrower submarginal dark vitta, none uniting at apex, the submarginal vitta being scarcely visible from above. Body beneath and legs reddish brown. Length 6.5 to 7.8 mm; width 3.8 to 4.4 mm.

Type male, U.S.N.M. no. 62,283, collected at Sunny Hill, Fla., taken from the stomach of a quail (*Colinus virginianus* subsp.).

Other localities.—Florida: Haw Creek, Hubbard and Schwarz; Fort Myers, Van Duzee, May 3–5, 1908, from H. F. Wickham collection; one specimen from Florida from the Charles Schaeffer collection. *Georgia:* Tifton, P. A. Glick; Thomasville, April 1926, on pecan leaf, T. L. Bissell. *South Carolina:* Allendale, August 15, 1935, J. N. Todd.

Remarks.—In my revision of the beetles of the genus *Oedionychis* published in 1927[3] I referred to a pair of these beetles as possibly new. At that time I did not dissect any of the beetles. Dissection proves that this is quite distinct from *Oedionychus petauristus* Fabricius. The markings are somewhat similar, but the median vitta in the former species is located nearer the margin and the lateral vitta becomes a submarginal vitta. The aedeagus is quite different, being bilobed at the apex instead of being acuminate. Moreover the deep groove of punctures on the elytra is unlike anything in *O. petauristus*. Five more specimens have accumulated in the last quarter century since my first publication, all from the southeastern United States.

[3] Proc. U. S. Nat. Mus. **70** (art. 23): 24, 1927.

HERPETOLOGY.—*On a collection of amphibians from Mount Kina Balu, North Borneo.* ROBERT F. INGER, Chicago Natural History Museum. (Communicated by Doris M. Cochran.)

In 1951 a field party led by Lt. Col. Robert Traub, United States Army, spent approximately one month on Mount Kina Balu, North Borneo. Although not the primary desiderata, cold-blooded vertebrates were collected. Amphibians were obtained at the following localities on the mountain: Bundu Tuhan, 4,500 feet; Lumu Lumu, 5,500 feet; and Kamaranga, 7,800 feet. All the material is on deposit in the United States National Museum.

In his paper summarizing the herpetology of Mount Kina Balu, Smith (Bull. Raffles Mus. **5:** 8–32, 2 pls., 3 text figs. 1931) lists 39 species of anurans. The Traub party collected 15 species, including one new species and two not recorded previously from the mountain. In the collection list that follows, the starred forms are new to the fauna:

Megophrys monticola nasuta (Schlegel): 4,500 feet.
Megophrys baluensis (Boulenger): 4,500 feet, 5,500 feet.
Megophrys hasselti (Tschudi): 4,500 feet, 5,500 feet.
Pelophryne misera (Mocquard): 7,800 feet.
Kalophrynus pleurostigma Tschudi: 4,500 feet.
Ooeidozyga baluensis (Boulenger): 4,500 feet.
Rana kuhli Duméril and Bibron: 4,500 feet.
Rana microdisca palavanensis Boulenger: 4,500 feet.
Rana luctuosa (Peters): 4,500 feet.
Staurois whiteheadi (Boulenger): 4,500 feet.
**Rhacophorus baluensis*, n. sp.: 4,500 feet.
Rhacophorus leucomystax (Gravenhorst): 4,500 feet.
Rhacophorus spiculatus (Smith): 4,500 feet.
**Rhacophorus colletti* Boulenger: 4,500 feet.
**Philautus bimaculatus* (Peters): 5,500 feet.

Rhacophorus baluensis, n. sp.

Holotype.—U.S.N.M. no. 130215 from Bundu Tuhan, Mount Kina Balu, North Borneo. An adult female, collected on July 5, 1951, at 4,500 feet by Dr. D. H. Johnson.

Description of holotype.—Habitus moderately robust; head as long as broad; snout pointed, projecting, much longer than eye diameter; nostrils much closer to tip of snout than to eye, directly above end of lower jaw; canthus rostralis sharp, the angle continuous beyond nostril to tip of snout; lores slightly oblique, feebly concave; interorbital a little wider than upper eyelid; tympanum flattened above, about three-fifths diameter of eye, less than its own diameter from orbit.

Fingers with large disks, those of outer fingers greater than tympanum; ventral surface of disks completely circumscribed by groove; web reaching base of disk of fourth finger, reaching disk on outer side of third finger, reaching subarticular tubercle on inner side of third finger, base of disk on outer side of second finger, distal edge of subarticular tubercle on inner side of second finger, and same point on first finger; subarticular tubercles well-developed.

Disks of toes smaller than those of outer fingers; all toes except fourth webbed to base of disks, fourth to distal edge of distal subarticular tubercle; an oval inner but no outer metatarsal tubercle; subarticular tubercles well-developed.

Skin above smooth; a horizontal fold from eye over tympanum to just beyond shoulder; chin

and throat rugose; abdomen and ventral surface of thighs coarsely granular; outer edge of forearm and fourth finger with a conspicuous smooth-edged ridge of skin; a similar ridge along outer edge of tarsus and fifth toe; a long, pointed dermal flap on the heel; a transverse ridge above vent, several conspicuous tubercles below vent.

Color (in alcohol) light grayish brown above with irregular darker markings on the back; canthal ridge light; sides dark gray with small, irregular, white spots; ventrally whitish; throat with a few very small dark spots; ventral surface of hind limbs peppered with dark dots; dorsal surface of limbs cross-barred; posterior surface of thighs dark gray; transverse ridge above anus white edged with black; tubercles below anus white.

Snout to vent 61 mm.

Paratypes.—U.S.N.M. nos. 130216–17, from the type locality.

These agree with the holotype in all details save coloration. Both paratypes have about twelve narrow dark bars across the head and back. The white spots of the sides are more abundant than in the holotype, and in one (130216 similar markings are scattered over the posterior surface of the thigh.

U.S.N.M. 130217 is a male with a grayish nuptial pad on the dorsomedian surface of the first finger. Slitlike vocal sac openings are present along the sides of the floor of the mouth. Snout to vent is 54 mm.

U.S.N.M. 130216 is an adult female; snout to vent is 64 mm.

Remarks.—This species most closely resembles *R. javanus* Boettger. The dermal appendages at the heel and over the vent are identical in the two forms. Though a ridge of skin occurs along the outer edges of the forearm and tarsus of *javanus*, these ridges are apparently less well developed than in *baluensis*. The webbing of the hand is more extensive in *baluensis*, that of *javanus* failing to reach the disks of the outer fingers and present only at the base between the inner fingers. The snout of *javanus* is blunt or rounded and only feebly projecting instead of pointed and strongly projecting as in *baluensis*.

Of the Bornean forms of *Rhacophorus*, *baluensis* resembles *fasciatus* Boulenger (type locality Akar River, Sarawak) and *shelfordi* Boulenger (type locality, Mount Penrissen, Sarawak). Neither of these, however, has a pointed dermal appendage at the heel or a distinct ridge of skin on the tarsus. Furthermore the nostril is equidistant from the tip of the snout and the orbit in the species described by Boulenger instead of much nearer the tip of the snout as in *baluensis*.

Rhacophorus spiculatus (Smith)

Though referred to the genus *Philautus* by Smith (op. cit.), the extensive webbing and the presence of well-developed vomerine teeth suggest closer relationship to *Rhacophorus*. The conical tubercles of the limbs and infra-anal region recall *Rhacophorus everetti* of Palawan although the latter species has no tubercles on the dorsal surfaces of head and body.

MALACOLOGY.—*The weight relations between shell and soft tissues during the growth of some fresh-water snails.* M. O. NOLAN and THEODOR VON BRAND,[1] National Microbiological Institute,[2] Bethesda, Md.

According to Thompson (1917), Nomura (1927), and Huxley (1932), the shell growth of snails is amenable to mathematical analysis. The shell of such snails as the Planorbidae can be considered as a logarithmic spiral, and its growth can be expressed adequately by the customary equation for allometric growth. So far no attempt seems to have been made to study whether fixed relationships exist between the amounts of shell material and soft tissues during the growth of snails. Such information, however, is of importance because physiological studies often involve a comparison in rates of certain processes, such as respiration, between various species or individuals of one species. Since the shell, though probably not entirely inert metabolically (von Brand, 1931; von Brand, Nolan, and Mann, 1948), certainly contributes at most a small fraction of the over-all metabolism, the quantitative weight relationships between shell and soft tissues assume a certain importance.

[1] The authors are indebted to Elizabeth M. Landry and Lawrence C. Pulley for technical assistance.

[2] Laboratory of Tropical Diseases.

MATERIAL AND METHODS

The snails used in the present studies were as follows:

1. *Australorbis glabratus*. Five strains.

a. Venezuelan strain maintained in the laboratory since 1947. Rearing methods have been discussed previously (Nolan, Bond, and Mann, 1953). Number of snails studied, 246; diameter range, 5.7–27.3 mm; weight range, 28.7–2025.3 mgm.

b. Venezuelan red (pigment-free) mutant strain reared from a self-fertilized specimen which appeared in the stock colony mentioned above; maintained as a true-bred variety for more than 2 years. Number of snails studied, 265; diameter range, 4.7–23.8 mm; weight range, 38.6–1330.8 mgm.

c. "Wild" Venezuelan strain collected at Acequia El Cortijo, about 5 kilometers northeast of the town of Villa de Cura in the State of Aragua. We are greatly indebted to Dr. J. A. Jove and his coworkers of the Ministry of Health of Venezuela for supplying the snails. The day after collection they were wrapped in moist cotton, packed in empty paraffin milk cartons, and, traveling by airplane, were received in Washington, D. C., two days later. They were maintained in aquaria with food provided until studies were completed within approximately 1 to 2 weeks following the date of collection. Number of snails studied, 114; diameter range, 7.6–18.1 mm; weight range, 56.0–572.8 mgm.

d and *e*. We are indebted to Dr. Charles Dobrovolny for two "wild" Brazilian strains transported in moist condition by plane to this country. In the laboratory they were maintained in aquaria as above. Studies of one strain, collected near Church, Olinda, were completed within 2 to 3 weeks after arrival. Number of snails studied, 98; diameter range, 7.0–16.6 mm; weight range, 55.0–574.4 mgm. Studies of the other strain, collected at Barro Novo, Olinda, were completed within 3 to 4 weeks following their arrival. Number of snails studied, 54; diameter range, 13.9–24.0 mm; weight range 261.0–1341.7 mgm.

2. *Aplexa nitens* collected near Brownsville, Tex., and maintained in the laboratory since 1949. Number of snails studied, 173; diameter range, 8.0–23.1 mm; weight range, 22.7–682.0 mgm.

3. *Lymnaea stagnalis* colony derived from laboratory-reared specimens obtained from Dr. L. E. Noland, University of Wisconsin. Number of snails studied, 213; diameter range, 8.5–40.6 mm; weight range, 18.8–2980.5 mgm.

Prior to obtaining weight determinations, each snail was removed from water and the outside of the shell dried with filter paper. The snail was placed on dry filter paper and allowed to crawl around until it began to slowly retract within its shell. Small pieces of filter paper were then inserted into the shell aperture and all visible moisture was removed. The total retraction of the body at this stage was just under half the length of the outer whorl. The water remaining between tissues and shell behind the foot and mouth parts was considered as part of the normal fresh weight of the snail. Weight was determined on an analytical balance. The snail was returned to water in order to ready it for removal of the body from the shell.

Before removing the body the snail was held with forceps and dipped into boiling water. With *Australorbis* it was important that the snail not be retracted before immersion in boiling water and the period of immersion be brief, 5 seconds or less. With *Aplexa* the period of immersion was 20 seconds and with *Lymnaea* 15 seconds. The snail was then held in the fingers under a dissecting microscope. A thin pliable hooked wire (fitted with a handle) was inserted into the muscular pharynx and the body pulled out in toto with gentle firmness, the pressure of the pull being in the direction of the curvature of the shell. The water that remained in the shell was driven off by heating in an oven at 100° to 105° C. The drying period was 1 to 2 hours for all specimens except large *Lymnaea* which required 3 hours for complete drying. The shell was cooled in a desiccator before being weighed on an analytical balance. Separate determinations on pieces of shell broken from the living animals showed that the shell contained very little water. The dried shell weight is therefore for all

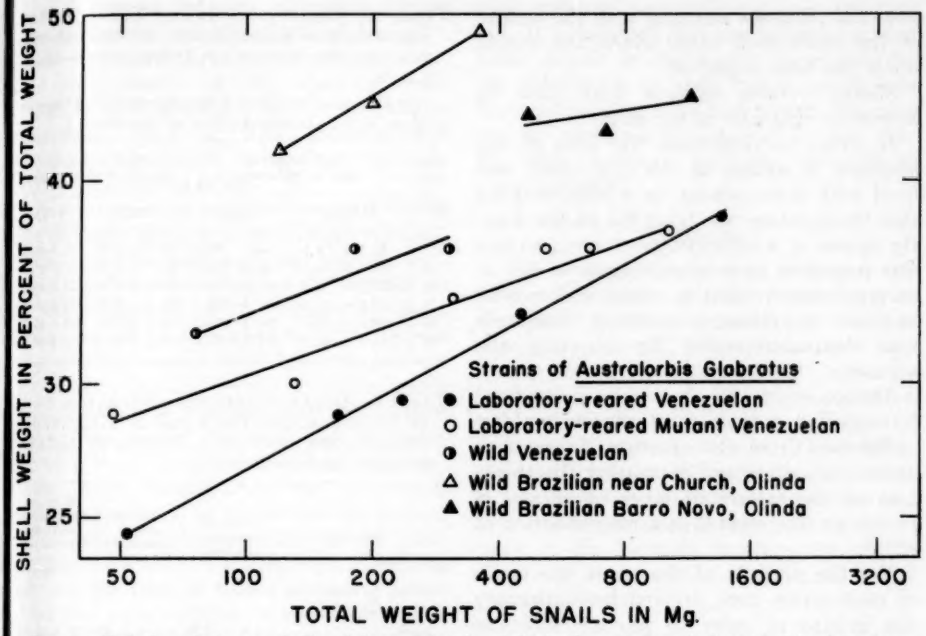


FIG. 1.—Relations between shell weight and total weight in five strains of *Australorbis glabratus*.

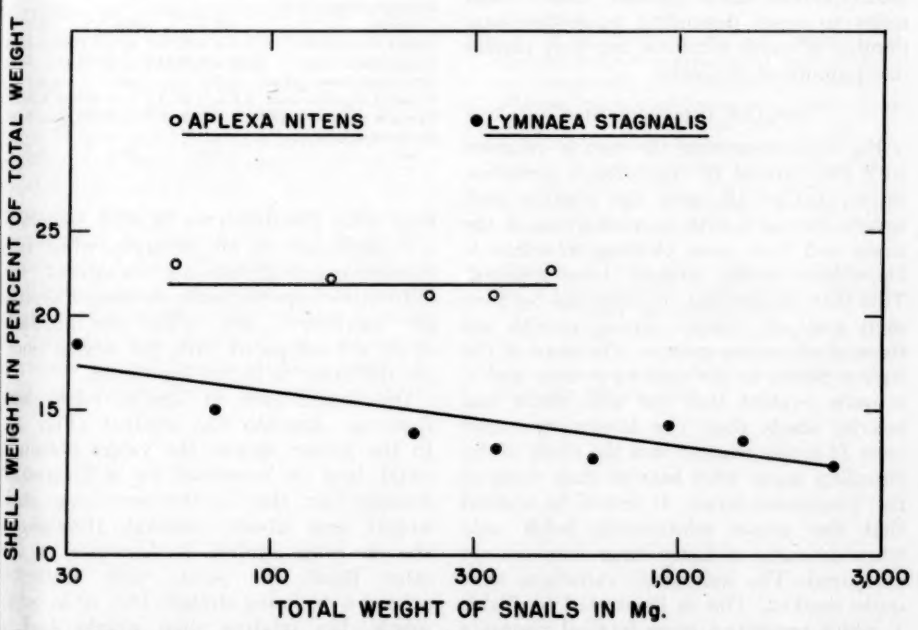


FIG. 2.—Relations between shell weight and total weight in *Apleza nitens* and *Lymnaea stagnalis*.

practical purposes identical with the weight of the fresh shell from which the excess water has been wiped off.

Sliding vernier calipers were used to determine diameter of the shell.

In order to determine the area of the aperture, a section of the last whorl was fixed with duco cement on a slide insuring that the aperture was lying flat on the slide. By means of a microprojector the aperture was projected at a magnification of 7.5 × on graph paper ruled in square millimeters, and its circumference outlined. The area was then determined by counting the squares.

Thickness of the shell was determined by isolating a fraction of the shell a few millimeters from the aperture, fixing it as above on a slide and measuring the thickness of the calcareous layer by means of an ocular micrometer at a magnification of 75 ×.

For the purpose of discussion the snails of each series were divided into arbitrary size groups in order to provide sufficient material for a valid average. The number of snails within these groups varied from series to series depending upon the total number of snails available but were similar in all groups of one series.

RESULTS AND DISCUSSION

Fig. 1, summarizing the results obtained with five strains of *Australorbis glabratus*, shows that in all cases the relative shell weight increased with increasing size of the snails and that, upon plotting on a double logarithmic scale, straight lines resulted. This then proves that the relations between shell and soft tissues during growth are those of allometric growth. The slope of the curves differs in the various strains, and it is quite evident that the wild strain had heavier shells than the laboratory-reared ones. It is also evident that the shells of the Brazilian snails were heavier than those of the Venezuelan strain. It should be realized that the above relationship holds only when averages of fairly large numbers are compared. The individual variations were quite marked. This is illustrated by Table 1, which presents a more detailed summary of our data for one strain. It is evident

TABLE 1.—RELATIONS BETWEEN TOTAL WEIGHT AND RELATIVE SHELL WEIGHT IN THE LABORATORY-REARED STRAIN OF AUSTRALORBIS GLABRATUS.

(In this and in Table 2 the figure following the ± sign is the standard error of the mean.)

Number of snails	Total weight of snail in milligrams		Shell weight in percent of total weight	
	Average	Range	Average	Range
57	52.3 ± 2.2	28.7– 99.9	24.8 ± 0.49	18.3–36.7
30	166.3 ± 4.2	100.4– 199.1	29.0 ± 0.69	21.2–38.6
46	237.7 ± 4.1	200.8– 298.1	29.6 ± 0.44	23.8–36.7
42	442.4 ± 14.6	303.8– 598.9	33.1 ± 0.51	26.4–39.8
40	800.9 ± 20.9	600.2– 996.3	35.6 ± 0.76	26.3–40.3
31	1314.8 ± 52.2	1013.7–2025.3	37.9 ± 0.73	30.5–48.9

TABLE 2.—RELATIONS BETWEEN DIAMETER, AREA OF APERTURE, AND THICKNESS OF CALCAREOUS SHELL LAYER IN SEVERAL SPECIES OF AQUATIC PULMONATE SNAILS

Species	Average diameter (in mm.)	Average area of aperture (in mm²)	Average thickness of calcareous layer of last whorl (in mm.)
Australorbis glabratus small	6.9 ± 0.20	1.9 ± 0.15	0.03 ± 0.00
Australorbis glabratus large	24.8 ± 0.55	16.1 ± 0.72	0.18 ± 0.01
Ratio small:large *Australorbis*	1:3.6	1:8.5	1:6.0
Aplexa nitens small	9.2 ± 0.26	2.1 ± 0.17	0.04 ± 0.00
Aplexa nitens large	21.6 ± 0.35	13.0 ± 0.58	0.11 ± 0.00
Ratio small:large *Aplexa*	1:2.3	1:6.2	1:2.7
Lymnaea stagnalis small	9.8 ± 1.00	2.1 ± 0.38	0.03 ± 0.00
Lymnaea stagnalis large	39.0 ± 0.36	47.1 ± 2.22	0.10 ± 0.00
Ratio small:large *Lymnaea*	1:4.0	1:22.4	1:3.3

that while the difference in shell weight is not significant in all instances when two successive size groups are considered, the differences between some successive groups are significant, and when the smallest snails are compared with the largest ones, the difference is highly significant.

One strain each of *Aplexa nitens* and *Lymnaea stagnalis* was studied (Fig. 2). In the former species the values obtained could best be expressed by a horizontal straight line, that is, the percentage shell weight was about constant throughout the size range studied. In *Lymnaea*, on the other hand, the points were scattered around a declining straight line, or in other words, the relative shell weight had a tendency to decrease with increasing size.

The difference between successive groups was in general not significant statistically. However, the difference between the average shell weight of the smallest snails (18.1 ± 0.38 percent) and of the largest specimens (12.9 ± 0.09 percent) was definitely significant indicating that the above relationship is real.

Several reasons may be responsible for the different pattern in the weight relationships between shell and soft tissues (evidently the relative weight of the soft tissues is the reciprocal of the values discussed above for the relative shell weight). Two of the possible reasons have been singled out for study. In all species of snails under consideration the whorls became increasingly larger, the larger the snail was and this increase in size occurred in all spatial dimensions. As a consequence the proportion between the bulk of tissue and its surface (which corresponds essentially to the inner surface of the shell) is shifted with increasing growth, the bulk of tissue increasing faster than the surface. This is shown in Table 2 where measurements are given for the diameter of the snail and the area of the aperture. It is evident that in all species the aperture became relatively larger, and that this feature was least developed in *Aplexa*. This point then would evidently tend to lower the percentage weight of the shell. It is counterbalanced by an increased thickness of the calcareous layer of the shell in the wider whorls. Table 2 shows that this increase in thickness was most pronounced in *Australorbis* and least pronounced in *Aplexa*. The increase in thickness of the shell tends, of course, to increase the relative shell weight. The relative increase in diameter was similar in the groups of *Australorbis* and *Lymnaea* under consideration; the differences in the ratios of diameter, aperture, and shell thickness are clear cut. It is believed that the balance between these points is essentially responsible for the differences in shell tissue proportions demonstrated between individuals belonging to one species but differing in size and for the different patterns observed in various species.

SUMMARY

The relationships between shell and soft tissues during the growth of three species of aquatic pulmonate snails are those of allometric growth. The percentage shell weight increases progressively with increasing size in *Australorbis glabratus*, remains constant in *Aplexa nitens*, and declines in *Lymnaea stagnalis*. These differences are related to differences in the change in ratio between the bulk of the tissues and their surface during growth and to differences in the increase in thickness of the calcareous layer of the shell in older and younger whorls.

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ICHTHYOLOGY.—*Four new fishes and one little-known species from the east coast of the United States including the Gulf of Mexico.* ISAAC GINSBURG, U. S. Fish and Wildlife Service. (Communicated by L. P. Schultz.)

The specimens on which the four new species here described are based, were obtained by the *Albatross III* on the coast of South Carolina and by the *Oregon* in the Gulf of Mexico and are deposited in the United States National Museum, including the four holotypes, except one paratype from the coast of Massachusetts deposited in the Museum of Comparative Zoology and three paratypes from the Gulf of Mexico in the University of Miami. The illustrations accompanying this paper were drawn by Mildred H. Carrington.

Family CONGRIDAE

Uroconger syringinus, n. sp.

The terminology and methods of study and measurements used in examining and describing this species are the same as used in my account of the eels of the northern Gulf coast (1951).

Description.—Trunk compressed to subterete, depth moderate. Tail well tapering, comparatively long, body 1.4–2.0 times in tail. Eye moderately large, 1.6–2.5 times in snout. Mouth rather large, its angle placed under middle of eye or slightly more backward. Jaws of medium extent; lower jaw moderately shorter than upper, 2.4–2.9 times in head. Snout blunt, 3.3–3.9 times in head, extenting moderately beyond lower jaw; premaxillary teeth exposed with the mouth closed, placed close to margin of upper jaw. Upper lip not forming an upturned fold, covered entirely by a broad fold of skin descending from the cheek; two tips of prolongations from buccal ossicle impinging on distal outline of fold and readily appreciable on external inspection; lower lip confined to the side of the jaw, falling considerably short of end of jaw, forming a broad fold deflected downward. Posterior nostril placed in front of and near eye, on a horizontal through middle of eye or slightly above its middle, its margin slightly or hardly raised; anterior nostril placed nearly on lateral aspect not far from end of snout, with a membranous well raised margin. A large pore directly over anterior nostril, extending partly more forward then nostril; a somewhat smaller pore at some distance behind and slightly higher; a medium sized pore directly behind anterior nostril; three very large elongate apertures at edge of cheek fold, the first near to medium sized pore, the third under anterior part of eye. Tongue free, rather well developed. Gill opening almost transverse, mainly lateral, rather large, slightly smaller or larger than distance between the two fellows. Dorsal origin on a vertical at a short or moderate distance behind pectoral base. Dorsal, anal and caudal continuous, of medium development except caudal moderately long (for an eel). Pectoral placed behind gill opening, at its upper angle, rather narrow, its length subequal to snout or slightly longer. Teeth slender, sharp, spaced, the anterior teeth generally rather large caninoid; teeth on side of both jaws in two well separated rows, the teeth in the rows similar, rather large anteriorly gradually or rather irregularly changing to posterior smaller teeth, posterior teeth in outer row smaller than those in inner row. In lower jaw the rows continued around symphysis but the two-rowed arrangement not as sharply marked there and the front teeth smaller than the anterior lateral teeth; a third lengthwise row of 4 or 5 teeth at anterior part of lower jaw, near midline, the teeth in this row becoming larger posteriorly, the two fellow rows somewhat diverging posteriorly, the hindmost two teeth in the third row largest of any in lower jaw. Upper jaw with anterior lateral 5 to 8 teeth graduated, growing larger posteriorly, thence gradually decreasing in size. Premaxillary teeth rather well separated from jaw and palatal teeth; in two transverse, nearly parallel, curving rows, 5 to 7 teeth in a row, teeth in outer row smaller, outer tooth of inner row largest of any in upper jaw. Palatal teeth preceded by one caninoid on midline or two caninoids, one behind the other, the anterior caninoid generally flanked on both sides by one smaller tooth, the one or two caninoids followed after a variable interval by a single median row of rather small, sharp teeth extending approximately to a variably placed vertical plane through eye.

Measurements of two specimens 255–279 mm, two specimens 313–333 mm, and one specimen 416 mm; the following proportional measurements given in three groups in the same order, respectively: body 37–41, 37.0–39.5, 33.5; trunk 23.0–25.5, 24.0–24.5, 21.5; tail 59–63, 60–63, 67; antedorsal 15.0–16.9; 15.4–16.0, 13.3; head

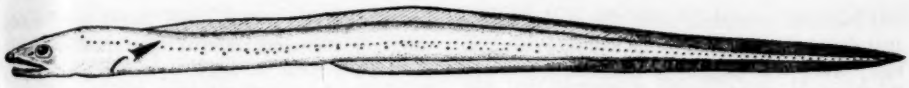

FIG. 1.—*Uroconger syringinus*, n. sp., from the holotype (U.S.N.M. 157781) from off Mississippi Delta, 50 fathoms (28° 45′ N., 89° 43′ W.); 279 mm.

14.3–16.4, 13.5–14.7, 13.6; upper jaw 5.4–7.3, 5.8–6.1, 5.2; lower jaw 4.9–6.8, 5.3–5.7, 4.9; snout 3.8–4.6, 3.9–4.3, 3.5; eye 1.9–2.3, 2.1–2.3, 1.4; depth 4.4–4.8, 5.0–5.3, 5.0; pectoral 3.7–4.8, 4.4, 3.5; caudal 2.8–3.4, 3.4–5.0, 2.3; body in tail 1.4–1.7, 1.5–1.7 and 2.0 times; snout in head 3.6–3.8, 3.3–3.4 and 3.9 times; lower jaw in head 2.4–2.9, 2.4–2.6 and 2.8 times; eye in snout 1.7–2.4, 1.6–2.1 and 2.5 times.

Prevailing color yellowish or grayish; ventral aspect and posterior part of tail with a lilaceous tinge more or less developed; head with a faint trace of lilaceous; greater posterior part of trunk and anterior part of tail with a lengthwise irregular row of very small dark dots, few or in moderate numbers, irregularly spaced, placed somewhat below midline; caudal and posterior part of dorsal and anal black.

Holotype.—U.S.N.M. 157781. *Oregon* station 10; lat. 28° 45′ N., long. 89° 43′ W.; off Mississippi Delta; 50 fathoms; May 28, 1950; 279 mm.

Paratypes.—Off Port Isabel, Tex.; 55 fathoms; 1 specimen 333 mm (U.S.N.M. 157789). Gulf of Mexico (exact locality uncertain) 3 specimens 255–416 mm (University of Miami).

Remarks.—A state of confusion appears to exist in the literature regarding the species hitherto placed in *Uroconger*. Richardson (1844: 106) in describing his *Conger lepturus* stated that it has two or three teeth on the palate ("vomer"). Kaup (1856: 110) paraphrased briefly Richardson's description and established his monotypic genus *Uroconger* based solely on this description. Bleeker (1864: 29) and also Day (1878: 661) followed by later, including very recent, authors use the name *Uroconger lepturus* for a species having a row of teeth on the palate, instead of two or three teeth as described by Richardson. Vaillant (1888: 86) described his *Uroconger vicinus* as also having two teeth on the palate. This corroborates Richardson's account in that at least one species with only two teeth on the palate does exist. Vaillant's *vicinus* might be the same as Richardson's *lepturus* or it might represent a distinct and closely related species; while the *U. lepturus* of Bleeker, Day and other authors is most likely a different species, possibly the same as *Congerodon indicus* Kaup (Arch. Naturg. **22** (1): 74. 1856).

The species here described differs from *Uroconger lepturus* (Richardson) in having a row of palatal teeth, instead of two or three. In this respect it agrees with the *U. lepturus* of authors (not Richardson). A specimen (269 mm) of what appears to be the latter species (U.S.N.M. 135309, taken off the southwest coast of Celebes) differs from *syringinus* as follows: body 30.5, tail 69.5, trunk 19.0, antedorsal 12.7, head 12.4. This species, then, has a longer tail and shorter body, trunk, antedorsal distance and head as compared with *syringinus*. The posterior part of the tail in this specimen is more attenuated as compared with the type of *syringinus* of nearly equal size.

In my recently published key to the Congridae of the northern Gulf of Mexico (1951: 437) the species here described falls in between *Congermuraena impressa* and the genus *Congrina*. It agrees with *Congrina* in that a broad fold descending from the cheek covers the upper lip

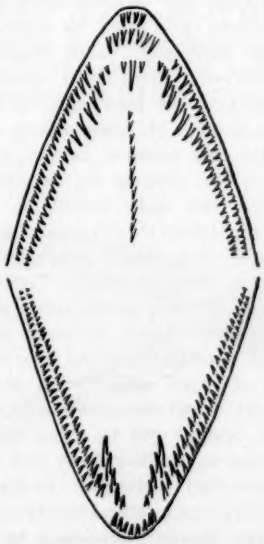

FIG. 2.—*Uroconger syringinus*, n. sp., dentition; semi-diagrammatic.

and contains extensions from the buccal ossicle that are readily appreciable on external examination. Also, the caudal is comparatively well developed as in *Congrina*. It differs from *Congrina* in the dentition in its sharp, slender teeth in 2 rows in upper jaw, three rows in lower jaw and nearly a single row on palate. The premaxillary teeth are placed near the end of the upper jaw instead of at some distance behind the end. The extent to which the snout projects beyond the lower jaw is about intermediate as compared with *Congrina* on the one hand and *Congermuraena* on the other.

In this species the relative length of the tail appears to increase with growth which is contrary to growth changes in other eels (see Ginsburg, 1951: 444 and passim).

Family Stromateidae

Genus **Cubiceps** Lowe

Cubiceps Lowe, Proc. Zool. Soc. London **11:** 82. 1843. (Genotype, *Seriola gracilis* Lowe by monotypy. The species is described under the above name; but the author suggests that it might belong to a separate genus and if so he proposes the name *Cubiceps* for it.)

The following description is based on and includes the characters common to the two species here treated.

Description.—Elongate, compressed, somewhat spindle shaped, but tapering more posteriorly than anteriorly. Eye large, its adipose margin moderately developed. Snout blunt, slightly longer than eye. Mouth small, moderately inclined, terminal, the jaws equal or lower jaw slightly projecting. Maxillary falling short of a vertical through anterior margin of eye, of moderate width, slipping for its entire length and greater part under suborbital, leaving a narrow or slight outer strip exposed; supplemental maxillary very thin, almost membranous, rather broad and of moderate length. Teeth small, of nearly uniform size, compressed, moderately pointed or rather blunt, close-set, in a single row in jaws; none on vomer and palatine. Opercular series of bones notably thin and flexible. Opercle with a well emarginate area at its posterior end, bridged over by a thin membranous area; without spines; its anterior part with slight ridges somewhat diverging backward. Gill opening wide; branchiostegal membranes separate all the way forward, continued to chin, the inner edge of the two fellows about parallel at their anterior extent. Pseudobranchiae well developed. Gill rakers well developed, easily countable including those at the ends of the arch, moderately long at angle gradually decreasing in size both ways. Pharynx muscular, bulging, its inner surface with thick, rather low, columnar bodies bearing slender, short, spine-like teeth. Mid-ventral line with a furrow between anus and pelvic fins. Scales cycloid, large to medium, about 39–68 oblique rows over lateral line; body including chest completely scaled, on antedorsal area scales extending to opposite anterior margin of pupil or eye; cheek scaled; snout scaleless, densely beset with small pores; opercle probably without scales, in large part anyway; base of second dorsal and anal fins with a densely scaled sheath; caudal scaled in large part, pectoral and pelvic fins scaled for some distance at their base; lateral line placed high, two longitudinal rows of scales between it and dorsal base, the scales with profusely branched channels. (Most or nearly all scales are missing in all specimens examined and some of the above statements are based largely on a study of the scale pockets. The extent of scalation on the opercle, if any, is not definitely determinable. The lateral line is best preserved in the holotype of *nigriargenteus*, its greater part, to about the twenty fifth scale, but the course of its posterior part is not determinable in any specimen.) Two completely separate dorsal fins; first dorsal with 11 more or less flexible spines, the anterior 4 unevenly graduated, fifth subequal to fourth, thence gradually and rapidly decreasing in length to last; second dorsal comparatively rather low, the first ray flexible or rather stiff, usually unjointed, presumably a spine homologically (in one specimen of *nigriargenteus* the first ray jointed), followed by 15 jointed and mostly branched rays, the rays rather widely spaced, posterior few rays somewhat thickened, the last ray notably thick and longer than preceding rays. The three anal spines stiff, pungent or the third somewhat flexible, unevenly graduated, anterior two short, the second a little longer than the first the third considerably longer, followed by 14 or 15 jointed rays, the soft rayed part of anal similar to second dorsal. Base of second dorsal and anal with a series of somewhat oval shaped or rounded fossae, the corresponding pair from the two sides usually continuous resulting in a series of perforations, every perforation placed between an adjacent pair of rays, at their bases. Pelvic reaching about half the distance from its base to anal origin or a little more; its outer spine more or less

flexible, falling moderately short of its apex; its outer angle a little behind lower pectoral angle, on a vertical nearly through origin of first dorsal or a little behind. Pectoral reaching a vertical at some distance behind end of pelvic; moderately falcate, the lower rays short, the longest rays a little below upper margin. Caudal with a deep V-shaped incision or well lunate.

Remarks.—It is doubtful whether the two species here treated are congeneric with *C. gracilis* (Lowe), the genotype of *Cubiceps*. However, the necessary material is unavailable to compare our two species with *gracilis* and to properly resolve the question of the limits of *Cubiceps* and its synonymy. The following two species are therefore only tentatively allocated to this genus.

Cubiceps nigriargenteus, n. sp.

D XI; (0) I 15 (16). A III 15. P 21–22. Sc about 39–56. GR 9–10 + 17–19.

Description.—First dorsal and anal counts constant in the eight specimens examined. Second dorsal typically with one flexible spine and 15 segmented rays (in 7); in one variant (U.S.N.M. 157775) the first fin support also a jointed (and unbranched) ray. Pectoral rays 22 (in 5) or 21 (in 3). Roughly about 39–56 oblique rows of scales over lateral line (not possible to determine the number with anything approaching accuracy as discussed below). Gill rakers 9 + 17, 9 + 18, 9 + 19 and 10 + 19 (the four counts listed in two specimens each). Beginning of scalation on dorsal aspect in a somewhat curved line situated over anterior margin of pupil, varying very slightly both ways.

Measurements of four specimens 138–174 mm and four specimens 199–229 mm, those of the smaller specimens in parentheses: caudal 22 in 1 (22–25 in 2), pectoral 23.5–25.0 (22.0–26.5), pelvic 14.2–14.9 (14.6–16.7), depth 26.0–27.5 (26.5–29.5), head 28.5–32.0 (29.5–32.0), maxillary 7.7–8.7 (7.2–7.9), snout 8.8–9.4 (8.6–9.6), eye 7.3–8.4 (7.6–8.6), interorbital 9.0–10.3 (9.0–9.9), antedorsal distance 32.5–33.5 (33–34), preanal distance (tip of snout to anal origin) 62–65 (60–63).

Color of the eight preserved and largely or almost wholly desquamated specimens as follows: Lower part of body and head silvery, upper part dark to nearly black, the more or less distinct boundary between the two colors being a nearly median longitudinal line. The above color pattern present in 6 specimens 138–221 mm. Two specimens 205–229 mm have a dusky color with the lower part only moderately lighter than the upper part and the color changing rather gradually from the back to the ventral aspect. No distinctive color marks.

Holotype.—U.S.N.M. 151954; off Cape Romain, S. C.; 92 fathoms; *Albatross III*; January 30, 1950; 189 mm in standard length; about 229 mm in total length.

Paratypes.—Sandwich, Mass., in fish trap (M.C.Z. 37183). Off Santa Rosa Island (U.S.N.M. 157774–5) and Pensacola (U.S.N.M. 157777), Fla.; taken by the *Oregon*. Total examined 7 paratypes 138–221 mm; taken by trawls, except the first one listed, in 112–175 fathoms.

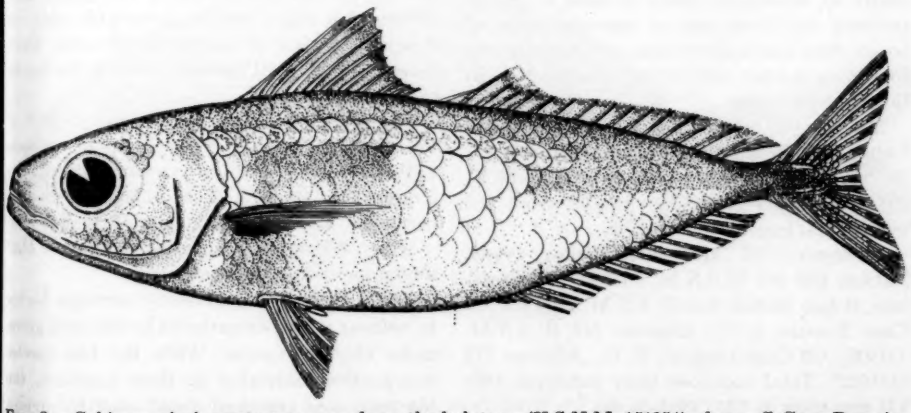

FIG. 3.—*Cubiceps nigriargenteus*, n. sp., from the holotype (U.S.N.M. 151954), from off Cape Romain, S. C., 92 fathoms; about 229 mm.

Remarks.—This species is near *C. brevimanus* Klunzinger from the Red Sea (Fische des Rothen Meeres: 116, pl. 12, fig. 3. 1884). As compared with the account of that species it differs in having 21 or 22 pectoral rays, instead of 24; and 11 dorsal spines, instead of 10. It is still nearer structurally to *melanus* with which it is compared below under the account of that species.

Cubiceps melanus, n. sp.

D XI; I 15. A III 14–15. P 21–22. Sc about 62–68. GR 9–11 + 18–20.

Description.—Dorsal spines and rays and anal spines constant in the nine specimens examined. Anal rays predominantly 15 (in 7), often 14 (in 2). Pectoral rays predominantly 22 (in 7), often 21 (in 2). Roughly about 62–67 oblique rows of scales over lateral line (not possible to determine the count with precision as discussed below). Gill rakers on upper limb 9 (in 2), 10 (5) or 11 (2); on lower limb 18 (2), 19 (4) or 20 (3); total number on both limbs 27 (1), 29 (5) or 30 (3). Beginning of scalation on dorsal aspect in a somewhat curved line situated over anterior margin of eye, varying very slightly both ways.

Measurements of eight specimens 138–174 mm and 1 specimen 185 mm, those of the smaller specimens in parentheses: caudal (21.5–23.0 in 3), pectoral 22 (22–24 in 6), pelvic 14.5 (13.7–14.8 in 4), depth 26.5 (25.0–28.5), head 31.5 (29.5–32.0), maxillary 9.4 (8.4–9.3), snout 10.6 (9.4–10.1), eye 8.1 (7.0–8.7), interorbital 9.8 (8.8–9.8), antedorsal 35 (33.5–35.5), preanal 64 (61.5–64.5).

Brownish dusky or nearly black, all over, or nearly so, sometimes silvery to some extent on posterior and lower part of opercular series of bones, chest and a narrow area on ventral aspect sometimes washed with silvery shades. No distinctive color marks.

Holotype.—U.S.N.M. 157779; off Mississippi Delta; 190–210 fathoms; *Oregon* station 382; lat. 29° 11′ 30″ N., long. 88° 07′ 30″ W.; June 21 1951; 153.5 mm in standard length, about 185 mm in total length.

Paratypes.—Off Mississippi Delta, *Oregon* stations 480–484 (U.S.N.M. 157780). Off Pensacola, *Oregon* station 314 (U.S.N.M. 157787). Off Cape Romain, S. C., *Albatross III* (U.S.N.M. 151903). Off Cape Lookout, N. C., *Albatross III* (151922). Total examined eight paratypes 138–174 mm taken in 125–200 fathoms.

Remarks.—This species is separable from *nigriargenteus* with much difficulty. They are distinguishable chiefly by four differences, namely the size of the scales, the color, the extent of scalation on the interorbital region and the maxillary length. The scale count possibly constitutes the best character for separating them, but in practice it cannot be applied with precision because the scales are deciduous and almost all or the greater part of the scales are missing in all specimens examined of both species. The scale pockets also are weak and nearly disappear so that their outlines are generally faint or hardly traceable in preserved specimens. The other 3 differences are slight or not sharply divergent.

The number of scales was determined by counting the oblique rows of the more or less faintly outlined scale pockets above the normal position of the lateral line. In 8 specimens of *nigriargenteus* the determined range is 39–56; in 9 individuals of this species it is 62–68. While the two species evidently differ in the number of scales, the given numbers are only very roughly approximate, because of the practical impossibility of making a precise count as stated.

The color of *melanus* is a nearly uniform dusky to black; while in most specimens of *nigriargenteus* the upper part is dark and the lower part silvery the two colors usually being rather sharply contrasted; but often the dark upper part blends gradually with a somewhat lighter color on the lower part of the body.

In *melanus* the scalation on the dorsal aspect extends approximately to over the anterior margin of the eye; in *nigriargenteus* approximately to over the anterior margin of the pupil. This difference is slight and is appreciable only on direct comparison of specimens. Morover, there is a slight individual variability within the limits of each species.

The maxillary length is 8.4–9.4 per cent of the standard length in 9 specimens of *melanus* 138–185 mm and 7.2–8.7 in 8 specimens of *nigriargenteus* 138–229 mm. This difference then is also slight and somewhat intergrading.

Other differences or possible differences that intergrade still more are as follows.

The gill raker count evidently averages higher in *melanus* as may be gathered by the data given under the two species. While the two species intergrade considerably in these numbers, the few specimens examined would seem to suggest

a degree of divergence of at least subspecies magnitude.

Two out of nine specimens of *melanus* have 14 anal rays, while in eight specimens of *nigri-argenteus* the count is constantly 15.

The few specimens measured suggest some possible slight average differences as follows: *melanus* having shorter fins, a slenderer body, longer snout and longer antedorsal. But these differences, if any, evidently are widely intergrading.

Palinurichthys bythites, n. sp.

D VI; I 23–25. A III 17. P 21–22. Sc 85–87. GR 7 + 16–17.

Description.—Body and caudal peduncle rather deep and compressed. Snout short, notably obtuse, its anterior aspect broad and nearly vertical (resembling that of a pompano). Eye large, subequal to or slightly smaller than snout. Adipose eyelid slight. Maxillary of moderate width, rather short, ending under middle of eye, exposed for its entire length; no supplemental maxillary, its upper part separated by an elongate groove but without an evident suture. Preopercle notably expanded, its distal lower margin broadly curved, slightly scalloped and slightly and rather sparsely serrate. Mouth small, very moderately inclined, placed low, a horizontal through distal margin of upper lip passing through lower margin of eye; subterminal, lower jaw slightly included. Teeth small, in one row in jaws; none on vomer, palatines and tongue. Gill opening broad, branchiostegal membranes united under eye. Pseudobranchiae moderate. Gill rakers well developed, broad, compressed, 7 + 16–17, including one small gill raker at either end of the arch. Pharynx muscular, bulging, its inner surface with low hummock-like projections, each with a group of sharp spine-like teeth. Scales cycloid, small, in 85–87 oblique rows over lateral line to caudal base (scales largely deciduous and count based on rows of scale pockets); body, including belly, chest, fleshy pectoral base and posterior part of predorsal area, almost altogether scaled, the squamation extending to a transverse, moderately oblique line a little behind upper angle of gill opening; a scaled strip at posterior boundary of cheek continued upward along preopercular margin behind eye; (opercle probably scaled, perhaps in part, skin on opercle destroyed in large part and scalation there indeterminable); rest of head naked; caudal scaled in its larger, proximal part; other fins scaled at their base. Head, from boundary of scalation forward, thickly beset with many pores forming openings to short, irregular channels under the skin. Lateral line slightly sinuous; its curve very moderately elevated, long, gradually merging with posterior straight part approximately over middle of anal base. Dorsal with anterior 6 spines well spaced, moderately stout, short, partly disconnected distally from one another, slightly graduated from first to fourth, fifth and sixth subequal to fourth; seventh spine abruptly

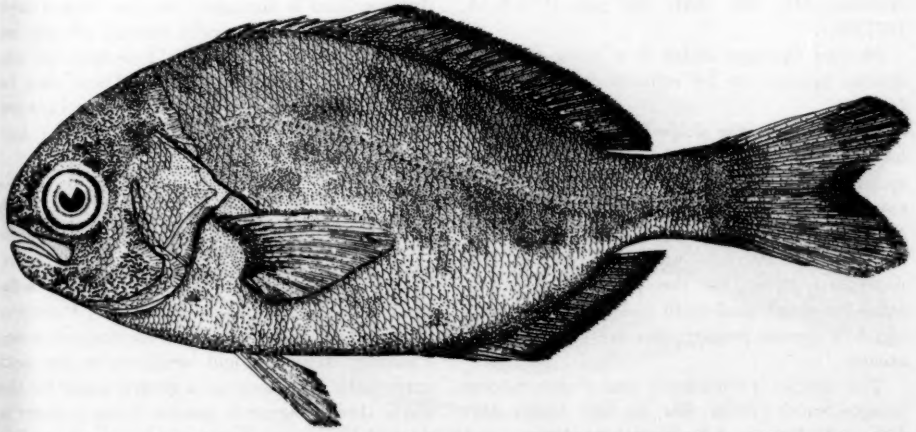

FIG. 4.—*Palinurichthys bythites*, n. sp., from the holotype (U.S.N.M. 157776), from off Pensacola, Fla., 220 fathoms (29° 27′ N., 87° 19′ W.); 253 mm.

longer and slenderer, closely approximated to soft rays (here considered part of second dorsal); the two dorsals continuous; anterior few soft rays graduated growing longer posteriorly, thence very slowly decreasing in length, first ray segmented and unbranched, others branched, last two rays rather thickened and closely approximated (here counted as two branches of one ray). Anal similar to dorsal except that the three spines well graduated connected to one another; spines and soft rays forming one continuous fin, and all rays including the first, branched. Ventral rather well developed, falling moderately short of anus. Pectoral broad, fifth or sixth ray longest, its distal oblique margin a nearly straight line, its length moderate, reaching a point approximately over anus. Caudal rather well emarginate, shorter than head.

Depth 43.0–45.5, head 32.0–32.5, depth of caudal peduncle 11.5–12.4, maxillary 12.0–12.4, snout 8.7–9.2, eye (measured between soft margins of lid) 7.8–8.7 (3.84–4.22 times in head), interorbital 11.8–13.7, ventral 20–21, pectoral 25.5–27.0, caudal 26–27.

Yellowish above, silvery below, the fins more or less dusky; no distinctive markings. (Nearly all scales are missing on the upper part of body and if any color pattern was present in life it might have been obliterated.)

Holotype.—U.S.N.M. 157776. *Oregon* station 321, lat. 29° 27′ N., long. 87° 19′ W.; off Pensacola, Fla.; 220 fathoms; April 28, 1951; 253 mm.

Paratype.—*Oregon* station 351, lat. 29° 13′ N., long. 88° W.; east of Mississippi Delta; 200 fathoms; May 22, 1951; 239 mm (U.S.N.M. 157778).

Stewart Springer states in a letter that this species appears to be common at about 220 fathoms.

Remarks.—By the shape of its snout particularly, and the short partly disconnected dorsal spines, this species resembles a pompano. However, the scales are larger and the caudal fin not as deeply forked as in pompanos, and the anterior dorsal and anal rays are not produced into prominent lobes. By the presence of sharp, spine-like esophageal teeth and by other characters this species properly belongs to the Stromateidae.

This species is apparently near *Palinurichthys pringlei* Smith (1949a: 304, fig. 849; 1949b: 844) from off Dassen Island, South Africa, and differs in having more gill rakers and possibly a somewhat deeper body. In the three species of this genus examined, namely, *bythites*, *perciformis* and *ovalis*, six specimens in all, the gill raker count is comparatively constant 6–7 + 16–18 (counted on both sides) while in the one specimen of *pringlei* recorded it is 7 + 14–15.

As compared with *Palinurichthys perciformis* (De Kay) from the northwestern Atlantic, this species differs at a glance by its deeper body and larger eye. It also has the short spines one less and the soft dorsal rays are more numerous. In three specimens of *perciformis* 230–287 mm from Ocean City, Md. (U.S.N.M. 57805), Barnegat Bay, N. J. (U.S.N.M. 104910) and Le Have, Nova Scotia (U.S.N.M. 22650): Depth 37.5–38.0; eye 6.1–7.1, 4.61–4.81 times in head. D VII; I 21–22.

A specimen 274 mm in standard length with the caudal damaged (probably near 345 mm long), labeled *Mupus ovalis* in the National Museum (23323), nearly agrees with Regan's description of his *Lirus ovalis* (1902: 198). Its counts and measurements are: Depth 45; eye 6.3, 4.64 times in head. D VI; I 31; A III 23. This species then has a higher dorsal and anal count than *bythites* and *perciformis*. Its body depth is as in *bythites* while the size of the eye as in *perciformis*. It further differs from the two western Atlantic species in that the last three short spines are somewhat graduated growing slightly larger posteriorly while in the latter two species the corresponding three spines are subequal or they grow slightly smaller posteriorly; but this difference is slight. The soft dorsal in this specimen is damaged, but the longest rays seem to be near its middle, instead of near its anterior part as in the two American species. But this difference also is slight. There seem to be no well-marked generic differences between the specimen labeled *ovalis* and *bythites* and *perciformis*.

The generic name to be used for the three species examined is uncertain. *Leirus* Lowe is preoccupied, hence it or its emended form *Lirus* is unavailable. Under his account of *Lirus*, Regan (1902: 195) lists *Mupus* Cocco, *Schedophilus* Cocco, *Crius* Valenciennes and *Palinurus* De Kay as synonyms, in chronological order. Therefore *Mupus* would seem to be the next name to be considered as a generic name for the above three congeneric species. Cocco's paper is unavailable to me for examination. According to Jordan (1919: 178) the type of *Mupus* is

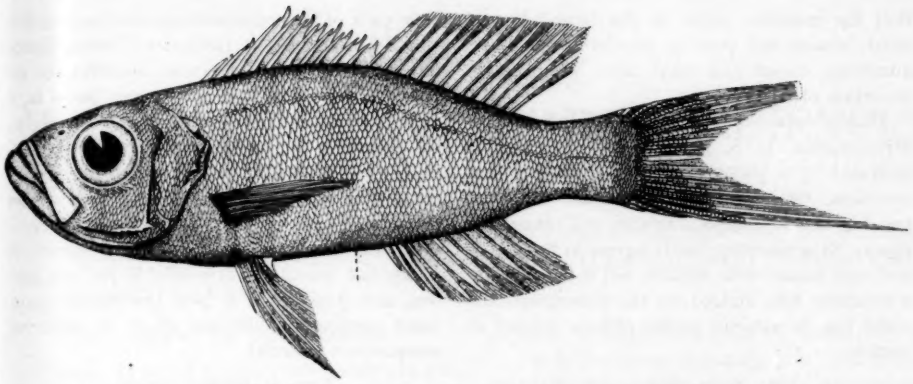

FIG. 5.—*Anthiasicus leptus* Ginsburg, from the holotype (U.S.N.M. 134189), off Dauphin Island, Ala., 68 fathoms (29° 14′ 30″ N., 88° 09′ 30″ W.); about 160 mm, 108 mm in standard length.

M. imperialis Cocco. The latter name is tentatively placed in the synonymy of *Lirus ovalis* by Regan (1902: 198). Consequently, according to these authors *Mupus* would seem to be properly applied to the three species here considered. However, neither Regan nor anybody else to my knowledge has determined definitely the taxonomic status of *Mupus imperialis* Cocco by a study of original specimens. Therefore, I here prefer to use for this species the generic name *Palinurichthys* Bleeker, which has been proposed as a substitute for the preoccupied name *Palinurus* De Kay, because that name has been most often associated with the American species of the genus.

Fowler (1936: 1281) substitutes Cocco's name *imperialis* for *ovalis* "by right of slight priority," also employing the generic name *Mupus*. However, he does not present evidence to prove the synonymy used or to settle the question of priority.

In our present connection attention should be called also to the following accounts:

Palinurichthys griseolineatus Norman (1937: 117), described from the Atlantic coast of South America apparently differs from our species in its more numerous dorsal and anal rays, judged by its description. The species identified by Norman in the same paper as *P. caeruleus* (Guichenot) apparently differs from ours in

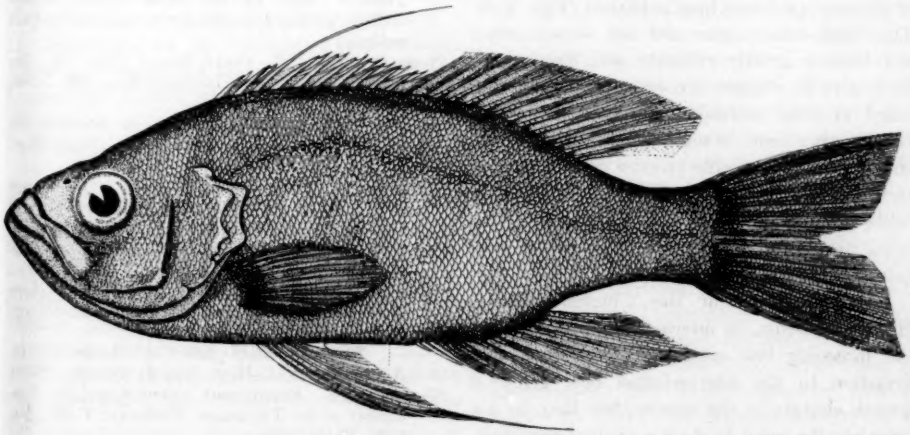

FIG. 6.—*Anthiasicus leptus* Ginsburg (U.S.N.M. 157788) from off Cape San Blas, Fla., 112 fathoms (29° 49′ N., 85° 45′ W.); 308 mm, 240 mm in standard length.

that the posterior curve in the lateral line is nearly absent and possibly also in having more numerous dorsal and anal rays. (Norman is uncertain of its counts.)

Toledia macrophthalma Miranda Ribeiro (1915: Stromateidae, p. 5, photo.) described and illustrated by a photograph from a single larger specimen, 680 mm, from the coast of Brazil possibly also represents a related and congeneric species. It apparently nearly agrees in the dorsal and anal counts with *bythites*, but it is evidently a slenderer fish. Judged by the photograph the snout has its anterior profile oblique instead of vertical.

Family SERRANIDAE

Anthiasicus leptus Ginsburg

Anthiasicus leptus Ginsburg, Journ. Washington Acad. Sci. **42** (3): 91, photo. 1952 (off Alabama).

This species was described from a single specimen 108 mm in standard length, about 160 mm in total length, taken by the *Albatross* in 1885. A considerably larger specimen which appears to be the same species was obtained by the *Oregon* (U.S.N.M. 157788). The counts of this specimen which is 308 mm long, 240 mm in standard length, are as follows: D X 14. A III 8. P 18. Sc about 86. GR 10 + 27. These characters then agree closely with those of the holotype, and it apparently belongs to the same species. If so, this species undergoes a remarkable change with growth, as shown by the figures of the two specimens here published (Figs. 5, 6). The third dorsal spine and the second pelvic ray become greatly elongate and filamentous. Such growth changes are now and then duplicated in other serranids, although not often. On the other hand, in some instances such differences constitute specific or even generic characters. But the most remarkable growth change takes place in the shape of the caudal fin, from being deeply lunate to the unusual shape indicated on the drawing (Fig. 6).

Four specimens in the Chicago Natural History Museum, in intermediate sizes between the foregoing two specimens, lend some confirmation to the interpretation here given of growth changes in this species; but they do not complete the series to show a gradual transition.

In view of these probable growth changes, the validity of the genus *Anthiasicus*, having *leptus* for its type species, becomes doubtful, as its distinction from related genera was based to a large extent on differences that now appear to be governed by remarkable growth changes. Perhaps *Anthiasicus* should be merged with *Hemanthias* which is based on *peruanus*, a species from the Pacific coast of South America. However, only one specimen of the latter species, in indifferent condition, is available for comparison, and *Anthiasicus* is here tentatively recognized pending an adequate study of pertinent, comparative material.

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